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THE EFFECTS OF INTERACTION BETWEEN GENOTYPES ON SINGLE PLANT SELECTION OF WHEAT (*TRITICUM AESTIVUM*)

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE EFFECTS OF INTERACTION BETWEEN GENOTYPES ON SINGLE PLANT SELECTION OF WHEAT (*TRITICUM AESTIVUM*) submitted by HENRIETTE A. KELKER in partial fulfilment of the requirements for the degree of DOCTOR OF PHILOSOPHY in PLANT BREEDING.

Abstract

In the first year of the study, the response of wheat plants to genotype interaction was studied on monocultures and mixtures of seven wheat genotypes, at seven different interplant spacings. The genotypes differed significantly in their response to genotype interaction.

In the second year, mixtures and monocultures of five genotypes were grown at two different interplant spacings. The mean variation of the number of tillers, plant weight and yield of the genotypes grown in mixtures at the closer spacing, and of kernel weight at the wider spacing, differed significantly from the mean variation in monoculture. For the plants grown in mixtures, an increase in spacing was accompanied by an increase in the plant to plant variation of the number of tillers, the number of heads, plant weight, yield, kernels per plant, kernel weight and harvest index. Similar effects were observed for plants grown in monocultures.

With the ecxeption of height of the flag leaf, plant height and harvest index, the effect of genotype interaction on plant characters differed significantly among genotypes. Correlations between pairs of characters, measured on genotypes and their associates, revealed that the characters which affect (or respond to) genotype interaction are not the same at different spacings and in different genotypes.

In the third year, the effect of initial seed size on plant interactions in five monocultures was examined. Number

of tillers, number of heads, and kernel weight were affected by initial seed size in plots from uniform seed. Plants from large seeds produced more tillers than did plants from small seeds, but plants from small seed produced larger kernels than did plants from large seeds. In plots from mixed seed sizes, however, neighbor interaction caused plants from small seeds to produce shorter plants, bearing lighter seeds, than did plants from large seed.

The data demonstrated that the distribution of many characters, in monoculture as well as in mixture, is not normal. It was shown that, if one selects the highest values for a character, characters which have a negatively skewed distribution are selected with less error than are characters for which the distribution is normal or positively skewed.

Yield trials of mixtures and monocultures were repeated for three years. Only in 1977 did the mixtures yield significantly more than the mean of the monocultures of the components. Interactions between the genotypes differed from year to year.

It was concluded, that the efficiency of selection of single plants from a segregating population is affected by variation due to different initial seed sizes, variation due to interaction between plants from different size seeds, and variation due to interaction between different genotypes, as well as by the frequency distribution of the observed characters.

It was recommended that, in order to evaluate the suitability of a character for selection in early generations, the distribution of this character in a multi-component mixture, as well as its sensitivity to genotype interaction, should be evaluated in conjunction with the estimation of its heritability.

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1. Introduction

In the history of wheat cultivation, the use of homogeneous cultivars is relatively new. Cultivated wheat populations used to be, and in some countries still are, composed of a large number of genotypes. For centuries, selection was practised by farmers for the plant types best suited for their needs. This resulted in plant types with large free threshing seeds, and increased yields, with better flour quality and with adaptation to a wide range of climatic conditions (Feldman, 1974). Although the principles of selection have been practiced in a more methodical way since the second half of the 18th century (Darwin, 1859), plant breeding has been recognised as a science only since the last part of the 19th century (Allard, 1960).

Almost all current selection methods for small cereals are based on line selection and its modifications (Sneep et al., 1979). These involve the selection of single plants or progeny rows in the early segregating generations.

It is widely recognised that single plant selection for quantitative characters, such as seed yield, in the segregating generations of a breeding program, is largely ineffective. Several studies have attempted to associate various plant characters in the F2 or F3 generations, with the expression of characters in more advanced generations (McGinnis and Shebeski, 1968; Hamblin and Donald, 1974). Interaction between genotypes is considered to be an important cause of the phenotypic variation which hinders

single plant selection (Kiesselbach, 1923; Christian and Gray, 1941). Yet, the effects of specific characters of one plant on the phenotype of its associates, and the implications of these effects for single plant selection, are unclear.

The present study focuses on the interactions between genotypes of common spring wheat (*Triticum aestivum* L.). The study was undertaken to determine the responsiveness of specific plant characters to the presence of other genotypes, and to evaluate the factors associated with the ability to perform well in a mixture situation. The results are discussed in relation to current plant breeding practices.

2. Literature Review

2.1 Terminology

Plant interactions have been studied by scientists from various branches of science, and each discipline has its own definitions and nomenclature. In 'The Origin of Species', Darwin (1859) discussed the competition which takes place between individuals within both the plant and the animal kingdoms. He preferred to use the term 'struggle for existence'. The term 'competition' was used by Odum (1971), who stated that competition, in the broadest sense, refers to the interaction of two organisms striving for the same thing. Harper (1961) described the different approaches of agronomists, ecologists and geneticists to plant competition. From an agronomist's point of view, competition is 'the response of plants to density-induced shortages'. The ecologist considers competition as 'all those forces by which one organism succeeds at the expense of another', while the geneticist deals with the 'effect of interaction operating between individuals of different genotypes within a population'.

A frequently quoted definition of competition was given by Clements et al. (1929), and reads as follows:
'Competition arises from the reaction of one plant upon the physical factors about it and the effect of the modified factors upon its competitors. In the exact sense, two plants

do not compete with each other as long as the water content, the nutrient material, the light and the heat are in excess of the needs of of both. When the immediate supply of a single necessary factor falls below the combined demands of the plants competition begins.'

Because the word competition is commonly associated with negative effects, its use has been avoided by several authors. Harper (1961) preferred the term 'interference', while Trenbath (1974, 1975) and Trenbath and Harper (1973) used the term 'neighbour effects'. Mather (1961) distinguished 'competition' from 'cooperation', and pointed out that individuals which are competing in one respect may be cooperating in another.

Hall (1974) attributed the responses of plants to their neighbours to both competitive and non-competitive interference. Competitive interference, as defined by Hall, is the same as competition for essential growth factors, as defined by Clements et al. (1929). Non-competitive interference occurs when an individual responds to changes in its environment, which are caused by other plants and which do not fall into the first category. As an example of non-competitive interference, Hall named the positive effect which a legume can have on the growth of a non-legume. This happens when nitrogen, fixed by the legume, becomes available to the non-legume through mineralisation (Henzell and Vallis, 1977).

The word 'interference' implies a one-way process. The mutual influences of plants upon each other can therefore perhaps be best described by the word 'interaction'. The effects of interaction between genotypes are measured as the phenotypic deviations of plants grown in mixed culture from those grown in pure culture, under otherwise similar growing conditions.

2.2 Mixtures vs. monocultures

The literature on mixtures of crop cultivars goes back at least as far as the last part of the 19th century, and the value and practicality of mixtures as a crop has been a much disputed issue. Von Rümker (1892) reviewed several of the older European studies and advocated the use of mixtures in an effort to increase the yield per unit area, especially where it concerned grains used for animal feed.

Montgomery (1912) concluded that, on the average, both oats and winter wheat had higher grain yields when grown in cultivar mixtures than when grown alone. Unfortunately he examined only two cultivars of each species in this study. Similar observations were made on wheat by Engelke (1935), who also noted that total tiller density was always higher in mixtures than in monocultures.

Data on a mixture diallel of four wheat cultivars (Nuding, 1936) were reanalysed by Simmonds (1962). He subsequently showed that the mean yield of the components in

monoculture was negatively correlated with their performance in mixture. The yields of the six mixtures all exceeded the mean yield of their component monocultures, and the highest yields were obtained from mixtures of genotypes which were known to have a wide range of adaptation.

In contrast to the above reports, Heuser (1938) concluded from the trials of five wheat cultivars and their binary mixtures, that monocultures yield at least as well as, and sometimes better than, mixtures do.

Three genotypes of wheat, which were similar in morphological characters, development and yield, produced yields in mixture which were similar to their yield in monoculture (Frankel, 1939). The similarity of the genotypes in this study might explain the lack of effect from genotype interaction.

A review of the more recent literature on the performance of mixtures of genotypes and mixtures of species was made by Trenbath (1974). The reviewed studies examined the biomass production of several forage, cereal and oil seed species. In 344 two-component mixtures, 60% of the mixtures - which is significantly ($\alpha \leq 0.01$) more than half - yielded more than the mean of the component monocultures, while 24% yielded more than the higher yielding monoculture. This suggests that, on the average, biomass production per plant is better in mixtures than in monocultures.

After evaluating a number of different types of rice (*Oryza sp.* L.) mixtures, mixing techniques and cultural

practices, Roy (1960) concluded that the chances for gaining or for losing yield potential through the formation of mixtures are about equal and that most advantages of mixtures are obtained when the soil conditions are poor. An advantage of mixtures over monocultures under extreme environmental conditions was also observed for barley (*Hordeum vulgare* L.) grain yield (Clay and Allard, 1969), in a study involving twentythree mixtures, evaluated over two years and five locations.

The performance of a mixture of two wheat cultivars (Pitic 62 and Neepawa), sown at various seeding rates differed in the two years of the study (Baker, 1977). This was ascribed to the fact that Pitic 62 was better able to compensate for poor survival after early drought conditions, when grown in pure stand, than when grown in mixture. The reason for this different ability to recover was not discussed, however. Further study of this observation could clarify the process of interaction which takes place between these two wheat genotypes.

Simmonds (1962) wrote an extensive review on the variation in crop plants, and indicated that mixtures, besides being often slightly superior in yield, are usually also more reliable in their performance, especially under conditions of stress.

It thus appears that in the majority of cases, stress conditions affect mixtures less than they do monocultures. With this in mind, it is interesting to note that in a study

by Shorter and Frey (1979), which was conducted over two years and at two locations, the genotype x year, the genotype x location, and the genotype x year x location interactions were insignificant most of the time (12 out of 16) for mixtures, and were always significant for monocultures.

For lima beans (*Phaseolus lunatus* L.), it was observed that the stability of performance is related to the degree of genetic variation in the population. Allard (1961) studied the performance of ten lima bean populations: three monocultures, three two-component mixtures, one three-component mixture and the advanced generations (F7 and F9) from crosses between these three genotypes. He found that, although the monocultures performed most often either very poorly or very well, the mixtures consistently performed at a mediocre level, while the bulk populations performed well most of the time. He concluded that the genetic diversity of the mixed and bulk populations apparently made them more stable.

The yield of five two- and three-way mixtures of barley genotypes appeared to be more stable over years and locations than were the yields of the component genotypes grown in monoculture (Early and Qualset, 1971). At the same time, a tendency was observed for the plant-to-plant variation within a genotype to be greater in mixtures than in monocultures. This is perhaps not surprising, since the micro-environment within the crop stand also is more

variable in a mixture of plant types than in a monoculture.

The reviewed studies suggest that mixtures often perform in a more stable manner than do monocultures. In order to evaluate the relative performance of mixtures and monocultures, it is therefore advisable to repeat any study of competition effects for a number of years. Close observation of single plant characters under both mixture and monoculture conditions during these years could reveal the mechanism underlying the stability of mixtures, and could possibly explain why certain genotypes are better combiners in a mixture

2.3 Types of interaction and interaction effects

Interactions between plants occur in monoculture as well as in mixed populations. Since developmental patterns of genotypes within a species can differ considerably, interplant relations within a mixture of genotypes will differ from those in monoculture. Interaction between plants of two different species or two genotypes of the same species can be detrimental, neutral or beneficial to either or both associates. Depending on the degree of interaction and the proportion in which each component occurs in the mixture, the mixture yields can be less than, equal to, or more than what can be expected from the monocultures of each component.

Since interactions vary with the growth stage of each of the plants involved, variation in the relationships between the individuals of a population can be brought about by varying the relative growth stages of the interacting plants. This can be achieved through variations in the time of emergence (Ross and Harper, 1972), variations in the seeding depth (Black, 1956), or variations in seed size of the population members (Montgomery, 1912; Kaufmann and McFadden, 1960). Interactions between components of a mixture can also be varied through variations in density (Kira et al., 1953; Chebib et al., 1973) or variations in the proportions of the mixture components (de Wit, 1960; Hill, 1974).

The effect on mixture yield of varying proportions of mixture components at a constant overall density has been studied by de Wit (1960) and by Hill (1974). De Wit introduced the term 'replacement series' for experiments, in which the performance of monocultures and mixtures containing a range of different proportions of two types of plants are assessed.

In de Wit's experiments, population pressure was maintained at a constant level by using optimal seeding rates appropriate for each of the components. Thus, in an experiment involving various proportions of oats and peas, oats were given 31 cm^2/kernel and peas were given 139 cm^2/kernel in all plots (de Wit, 1961).

De Wit's model assumes that the genotypes in a mixture exclude each other and crowd for the same 'space'. Space is assumed to be uniformly distributed and encompasses all essential growth factors. De Wit considered it undesirable to define these factors, since: 'such a description is not necessary, always inaccurate and therefore inadvisable.' (de Wit, 1960). Hall (1974) explained, however, that identification of a particular limiting factor could give valuable insight into the interaction process.

A replacement diagram consists of curves which represent the measurements on yield or other characters for each mixture component, obtained from a series of mixtures of different proportions, as well as a curve representing the sum of the component yields (total mixture yield) for each mixture. These diagrams can take on any of the basic shapes given in the figures 1a to 1d, and can be explained as follows, using plot yield as an example:

1. Interaction between genotypes has no effect on the yield of either one of the mixture components (Figure 1a).
2. Interaction between genotypes decreases the yield of genotype A, while it increases the yield of B (Figure 1b). The combined effects, however, cause no change in the total yield of the mixture. One can speak in this case of 'complementary competition' (Shuts et al., 1968).
3. Interaction between genotypes decreases the yields of both A and B (Figure 1c). This can result in a total

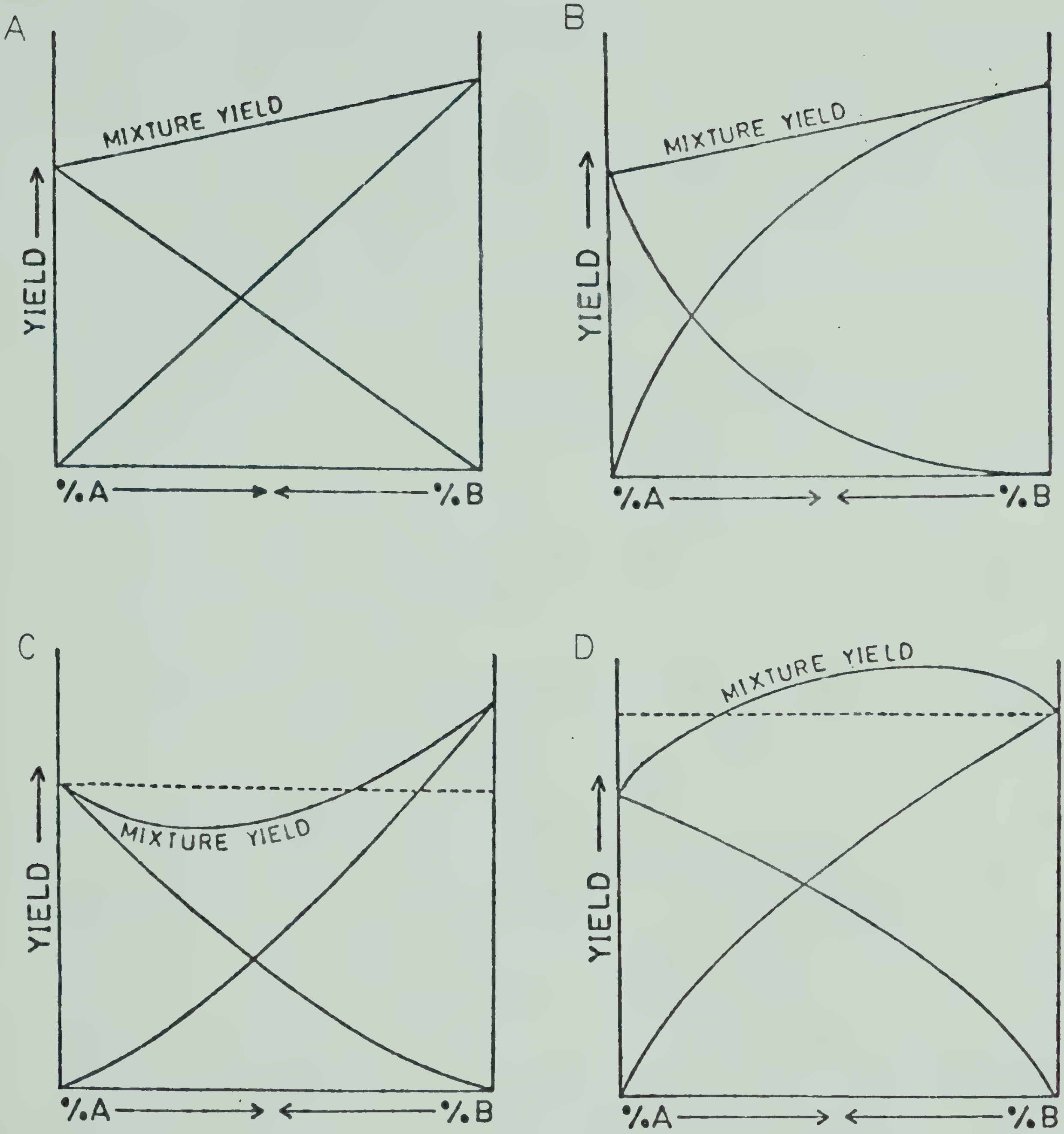

Fig. 1a-d Graphic illustration of four possible types of genotype interaction effects on genotype and mixture yield of two genotypes, A and B, grown in binary mixtures of varying proportions ('Replacement Series').

%A and %B in the mixture are marked a ong the X-axis, reading from left to right for genotype A, and from right to left for genotype B.

mixture yield intermediate between the yields of A and B grown in monoculture (section 'p') or in a total mixture yield which is less than the monoculture yield of the lower yielding genotype (section 'q'). In the latter case one can speak of 'underyielding' of the mixture (Trenbath, 1974).

4. Interaction between genotypes increases the yields of both A and B (Figure 1d), resulting in a total mixture yield which is lower than the yield of the better monoculture, but higher than the yield of the poorer monoculture (section 'p'), or in the mixture yield being higher than the yield of the better monoculture (section 'q'). In the latter case one can speak of 'overyielding' of the mixture (Trenbath, 1974).

An understanding of the mechanisms leading to overyielding could be exploited to increase yield. In general, overyielding occurs in mixtures of species which exhibit marked differences in their pattern of growth. These differences provide the potential to utilise the available resources more efficiently (de Wit, 1961; Trenbath, 1974; Clark, 1980). In herbage plants, Hill (1974) demonstrated that a 50:50 mixture is not usually the optimal composition to maximise forage yield. This conclusion agrees with the diagram in Figure 1d, which shows that overyielding is more likely to occur in mixtures containing a higher proportion of the better yielding genotype.

Differences between genotypes of cultivated cereals are probably more subtle than are those between the components of a mixture of species, because plants of the same species are more similar in growth habit and nutrient requirements. Nevertheless, the presence of genetic differences implies the existence of differences in the various aspects of plant growth. Thus, the potential exists for complicated interplant relationships, which are different from those occurring in a monoculture.

A great number of factors play a role in plant interactions. There is therefore little hope that a generalised set of rules can be designed from which the outcome of plant interactions can be accurately predicted. Hill (1974) recognised this when he presented a theoretical model for the prediction of the value of binary mixtures of herbage species. He emphasised that plant interaction is a dynamic phenomenon, and that relationships can be transient.

2.4 Effects of plant interaction on plant growth

2.4.1 Plasticity of plant characters

The ability of plant parts and processes to respond to variations in the environment has been extensively discussed by Bradshaw (1964). He presented evidence that the plasticity of a certain character

a. is specific for that character,

b. is specific in relation to particular environmental influences,

c. is specific in direction,

d. is under genetic control, not necessarily related to heterozygosity, and

e. can be radically altered by selection.

His theories on the role of plasticity of plant characters in evolution and adaptation apply directly to the interpretation of interactions between plants of different genotype. Bradshaw proposed that the plasticity of a character is related to the duration of meristematic activity which pertains to its development. Stemlength, for example, is controlled by long periods of meristematic activity and will therefore be more susceptible to environmental influences than are characters which are formed rapidly, such as reproductive structures. However, within this framework, there exists great variation among species as well as among genotypes within species.

Bradshaw explained that as a result of natural selection, a character whose stability is important for survival will likely show greater stability than will a character for which some plasticity is not a disadvantage. Harper (1961) pointed out that seed size is often surprisingly stable, thus ensuring an equal starting capital for each seedling. Significant variations in seed size due to interaction between genotypes, however, have been reported for wheat

(Christian and Gray, 1941; Chapman et al., 1969).

For some characters, plasticity can play a great role in adaptation. Height of many species appears to be a very plastic character. Trenbath and Harper (1973) described the different abilities of several oat species (*Avena sp.* L.) to adapt to different competitive situations through changes in height. *Avena sativa* was found to be capable of a stem extension of 10 cm above its monoculture value when grown in association with the taller *A. ludoviciana*. This resulted, for *A. sativa*, in a 20% increase in kernel weight over its monoculture value. They discussed the biological significance of this 'extension response' and concluded that such a mechanism must lead to a more even sharing of radiation. In natural communities this would conserve genotypes and thus diversity.

In corn the rapid elongation rate of one plant has an accelerating effect on the elongation rate of its neighbours (Hozumi et al., 1955). This effect appeared to be transient, however, resulting in an oscillating pattern of elongation rate in each plant.

Because environmental conditions in the field vary a great deal, stability of certain characters necessarily implies plasticity in others. Plant height, for example, is in a monoculture usually very uniform. Plasticity must therefore exist in some characters which determine plant height , such as elongation rate at various stages of development. Plasticity of the components of a certain

character can result in either stability or plasticity of the resultant character. Plant weight and grain yield of cereals are not considered as stable characters, nor are most of their components. However, harvest index, which is the ratio of grain yield and plant weight, is surprisingly stable over a range of environments (Donald and Hamblin, 1976).

If the degree of plasticity of various characters is genotype specific, as suggested by Bradshaw, then this could have important implications for a genotypes ability to perform in a mixture. Sakai (1955) concluded from a study of twelve barley cultivars that this 'competitive ability' was not associated with any of the characters he measured: plant height, maturity, seed size, habit of growth (erect vs. prostrate), heading habit (spring or winter) or grain yield. He concluded that competitive ability is a biological character in its own right and is under genetic control.

This conclusion has been criticised by several authors (Donald, 1963; Harper, 1965). Harper (1965) pointed out the incompleteness of Sakai's list of characters and stressed the importance of further investigations involving characters such as depth and extent of the root system, leaf area and height of the flag leaf. Sakai's theory on competitive ability as a genetic character is in agreement, however, with Bradshaw's views (1964) on the genetic control of the plasticity of each individual character.

2.4.2 Competition for water and nutrients

Suneson (1949) described experiments involving a mixture of four similarly adapted barley cultivars. Over sixteen years, two of the four components virtually disappeared from the population, even though one of them, Vaughn, had a significantly better yield potential and resistance to leaf diseases than any of the others when grown in pure stand. Atlas, the cultivar which eventually dominated the mixture, had the poorest leaf disease record and a mean yield below the median of the component cultivars.

Subsequent attempts to analyse the relationships between Atlas and Vaughn revealed that competition for light was not a decisive factor (Edwards and Allard, 1963), but that competition was primarily for moisture and nutrients (Hartmann and Allard, 1964). Lee (1960) observed that the response to competition between the two cultivars appeared abruptly at the jointing stage, when Atlas developed a dense mass of crown roots. Since Vaughn did not develop as large a root mass, Lee suggested that Atlas would become more efficient in gathering nutrients and would have the advantage when both varieties have to draw from the same soil mass.

Competition between roots usually starts long before the shoots are sufficiently developed to cause significant mutual shading (Milthorpe, 1961). But, competition for nutrients often leads to competition for light, since an

unevenly distributed nutrient supply will result in a similar variation in shoot growth. The study of nutrient competition without consideration of competition for light is therefore possible only under conditions which artificially prevent intermingling of the leaves of neighbouring plants.

Such studies have been performed by Donald (1958) on a mixture of grasses and by Aspinall and Milthorpe (1959) on barley and white persicaria (*Polygonum lepathifolium* L.) Both studies involved mixtures of species grown in pots.

Aspinall (1960) concluded that root competition, presumably for nutrients, since water was supplied in adequate amounts, reduced growth of the less successful component more than did shoot competition. Donald emphasised the interaction which occurs between competition for light, competition for nutrients, and factors indirectly affected by the two.

Both authors mentioned differences in embryo size and in the size of the root systems of species as the main causes of competitive interference in the early stages. These same factors should then play a role in pure stands if random variation occurs in initial seed size and rate of germination.

2.4.3 Competition for light

For most crop species, photosynthetic rate in an individual leaf is saturated at 150,000 - 200,000 lux (Donald, 1961). This is well below the flux density experienced by the top layer of a canopy on a sunny day. In a closed crop stand a large part of the foliage is shaded and will receive light intensities which are below the level of light saturation, except perhaps during the midday hours on a very bright day.

Horizontal as well as vertical distribution of the leaves and leaf angle will affect the amount of light which can be intercepted and utilised by a crop. Erect leaves will allow more light to penetrate into the canopy, enabelling a larger leaf area to take part in photosynthesis.

Competition for light within a canopy will not occur until the photosynthetically active radiation which reaches the surface of the leaf falls below the saturation level. With higher light intensities, competition will occur deeper inside the canopy.

Donald (1967) described the ideal wheat plant for cultivation at high densities, such as are customary for most cereals, and suggested that it should have small erect leaves. This would maximise the area which is illuminated. Nichiporovich (1967) also discussed this subject and stressed that a different leaf angle will be optimal at different latitudes or climates. According to the latter, some cereals have an arrangement of leaves in which the top

leaves are approximately vertical, the middle leaves are inclined at intermediate angles and the lower leaves are nearly horizontal. Nichiporovich considered this the ideal arrangement for plants to be grown at high densities. In a mixture of genotypes, this type of plant would also be less susceptible to shading by taller plants, than would types with more horizontal leaves.

Donald (1961) stated that competition for light takes place between leaves rather than between plants or species. This is well illustrated by the studies of Brougham (1958) on competition for light in a sward of white clover. It was shown that, following defoliation, mature petiole length of successive leaves became longer, suggesting an attempt to reach daylight through the increasingly dense canopy.

Because the growth patterns of genotypes differ from each other, the start of plant interactions and their effects on subsequent processes will be different in mixtures than in monocultures. Trenbath and Harper (1973) found that, under optimal moisture and nutrient conditions, reactions of Avena species to genotype interaction could be explained in terms of the shading experienced at different stages of development. Early shading appeared to have a depressive effect on tiller number, while shading of the flag leaf during grain filling had a pronounced effect on seed weight.

The effects of shading on wheat at different points in development were studied by Fischer (1975). He found that

the period of rapid spike growth was the most sensitive to shading, resulting in fewer grains per spikelet and low tiller survival.

A negative correlation between shoot elongation rate and shoot length tended to equalise the height of corn plants during the first few weeks of growth (Hozumi et al., 1955). This effect caused temporary variations in the shoot elongation rate of individual plants. Later in the season, when competition became more severe, this correlation changed into a positive one, suggesting suppression of small plants by taller neighbors.

Growth rate of the high yielding dwarf wheat cultivar Yecora was found to be sensitive to low shading intensities, of three to four weeks duration, at various times during the growing season (Fischer, 1975). Shading at any time reduced crop growth rate. The strongest reductions in yield, however, occurred when the plants were shaded during the month before anthesis. Although the shading treatments in these experiments involved complete plots, one can expect shading by taller neighbours to have similar effects.

Yoda et al. (1957) found that the growth of rose mallow (*Hibiscus moschentos* L.) seedlings, during the latter part of the growing season, was more closely related to the relative size rather than to the absolute size of neighbouring plants. They discussed Hozumi's findings as well as their own, and concluded that the change from a negative to a positive correlation between plant size and

growth rate marked the point where the growth reductions due to reduced photosynthesis surpassed the etiolating effects of competition for light. The change from a negative to a positive correlation occurred earlier in dense plantings than at wider interplant spacings, supporting this theory.

An increase in the mean plant height of a mixed wheat population was observed by Khalifa and Qualset (1975), who planted the progeny of a cross between short statured and standard height wheats, without artificial selection, for six generations. They found that the frequency of short statured plants in the population decreased, suggesting that tall plants were more successful in setting seed, in spite of a significant negative correlation between height and yield.

In a similar study Busch and Luizzi (1979) found no evidence of such a directional shift. They ascribed this lack of change to either a lesser genetic range in height in their material or to the lesser expression of height differences in the more limiting dryland environment of North Dakota, compared to that of California.

2.4.4 Effects of seed size on plant interactions

The place that an individual occupies within the hierarchy of a plant population seems to be largely determined in the very early stages of plant development (Harper, 1977). Seed size is one of the first factors affecting this early development, and it was shown by

Austenson and Walton (1970) that a two or three fold difference in weight can exist among kernels of wheat in the same head.

The effect of seed size on plant development has been quantitatively studied by various authors. Kiesselbach (1924) reviewed a number of investigations made on cereals around the turn of the century, and added to this many of his own findings. He concluded that:

1. When small and large seeds of various cereal crops were space planted, small seeds developed into considerably smaller plants than did large seeds, giving correspondingly lower yields (on the average 19% less). This result was ascribed to the differences in energy reserves of the seeds, and hence, in initial seedling vigour.
2. When equal numbers of small and large seeds were planted at a rate optimal for the large seeds, the reduction in yield of the plants from small seeds was less than the reduction at wide spacings, although the small seed plants still yielded on the average 11% less than did the plants from large seed.
3. When equal weights of the two types of seed were planted, the plants from small seeds yielded on the average 3% less than did the plants from large seeds. The greater number of small seeds planted compensated almost completely for the smaller size. When equal weights of large seeds and unselected seeds were

planted, the plants from unselected seeds consistently yielded slightly more than the plants from large seeds. Averaged over 131 test years, the advantage of unsorted seed over large seed was 2.1%. The author did not speculate on the cause of this more efficient performance of a mixture of seed sizes.

Interaction between plants from different seed size within a genotype, and between genotypes differing in growth rate, was studied by Christian and Gray (1941). In both late and early cultivars of wheat, seed size affected the number of tillers and the number of heads per plant. Differences between the genotypes in their performance in mixture affected the the number of heads per plant but not the number of tillers per plant. Thousand kernel weight of the early genotype was significantly reduced by competition from the late genotype, but the latter was not affected.

A similar study was conducted by Kaufmann and McFadden (1960). They studied the competitive interactions between barley plants grown from large and small seeds, and concluded that plants from small seed are more negatively affected by increased plant density than are plants from large seed. The main character responsible for the yield reduction in response to increased density was the number of heads per plant. They reported a ratio of yield from large and small plants of 1:0.78 at a 10 cm equidistant spacing and a ratio of 1:0.54 at a 5 cm equidistant spacing. Comparisons of yield from plots seeded to equal numbers of

either uniformly large seeds or uniformly small seeds revealed, as did the studies of Kiesselbach (1924) and Christian and Gray (1941), a higher yield for the large-seed plots.

The effects of seed size on components of yield were studied in more detail by Austenson and Walton (1970). They found that, within each of three cultivars of wheat, total yield, grain yield, straw yield, the number of heads per plant and number of seeds per plant were significantly correlated with initial seed weight. Variation in initial seed weight accounted for from 2.5 to 4.5% of the variation in these characters at maturity. Thousand kernel weight and number of seeds per head appeared to be unrelated to initial seed size.

Black (1958) demonstrated that, in two swards of subterranean clover, derived from equal numbers of seedlings but from different seed sizes, all plants in both swards eventually reached the same size. When large and small seeds were mixed, however, the plants from large seeds progressively suppressed the plants from small seeds and eventually made up 90% of the dry weight and leaf area of the sward.

Black noted that the relative growth rate of both the swards from large seeds and small seeds declined once a critical leaf area was reached. The plants from large seed reached this point faster than did the plants from small seed.

Kaufmann and McFadden (1960) reported that the vigorous growth of barley plants from large seeds resulted in an earlier development of second and subsequent leaves and of tillers than was the case for plants from small seed, but no difference was reported in the onset of flowering.

The importance of seed size and seedling growth rate to interplant relationships was demonstrated by Aspinall and Milthorpe (1959) and Aspinall (1960), who studied the interaction between barley and white persicaria. They concluded that, although in pure culture white persicaria has a faster relative growth rate than does barley, the latter has a larger embryo and initial seedling size, enabling it to establish a larger root system more rapidly and thus to gain an advantage when grown in a mixture. Restricted nutrient supply appeared to depress the growth of white persicaria more than did shading by the barley plants.

At the onset of flowering of the barley plants, when barley root growth and leaf expansion decrease, the persicaria plants immediately increased their growth rate, demonstrating the changes in interplant relations which can occur as plant development progresses.

Litav and Isti (1974a,b) compared the growth of seedlings of large and small seeded spinach (*Spinacia oleracea* L.) strains. Both strains gave the same individual plant yield in pure culture. The authors concluded from their experiments, which were grown at two levels of fertility, that a larger embryonic capital is only an

advantage when nutrients are in short supply. An experiment involving two seed sizes and two fertility levels, showed that an increase in soil fertility enables seedlings derived from smaller seeds to maintain an advantage when seeded earlier than the larger seeds.

A study of a more qualitative nature was made by McDaniel (1969), who investigated the relationship of seed weight, seedling vigour and mitochondrial metabolism in barley. He found that seedling fresh weight, seedling mitochondrial protein and mitochondrial biochemical activity were positively correlated with seed weight. Although the number of mitochondria per unit fresh weight was the same for all classes of seed size, relatively more mitochondrial protein was present in seedlings from large seeds, resulting in a higher respiratory activity. The greater energy production in seedlings from large seeds thus allows a higher growth rate of these seedlings than of the seedlings from smaller seeds of the same genotype (McDaniel, 1969).

Seed size, thus, affects early growth rate of seedlings and is therefore an important factor in determining the competitive advantage or disadvantage of a plant at the time that a shortage of growth factors occurs.

2.4.5 Effects of density on plant interactions

Interaction between plants will start earlier in dense stands than in more widely spaced plantings. However, there is no direct effect of plant density upon plant growth. All

responses to density are indirectly measured as responses to limits on growth factors. Using wheat plants, grown at four different densities, Clements et al. (1929) observed that the effects of density resembled the effects of a water shortage. Pot cultures with different levels of soil moisture, fertiliser and light intensity, confirmed their theories and they concluded that, under their growing conditions, with increasing density, competition for water is most severe, with competition for nutrients and for light playing important, but secondary, roles.

Harper and Clatworthy (1963) studied changes in light absorption in swards of *Trifolium repens* L. and *T. fragiferum* L. grown at two densities. For both species, initial differences between the two densities in light extinction and leaf area had almost disappeared after fifteen weeks of growth. Apparently light was the limiting factor at both densities and an LAI of about five for T. repens and of six for T. fragiferum was the maximum that could be maintained, under the provided light regime.

Increasing population density, therefore, may be regarded as an increase in competition for light, nutrients and water among associated genotypes. Donald (1958) emphasised that, even if competition occurs for only a single factor, there will be interaction between direct and indirect effects. Competition for nutrients, for example, may affect shoot growth, and this may modify competition for light.

Harper (1961) distinguished two ways in which plants may react to density. Firstly, an increased density may result in a reduced chance for survival. He described the results of studies concerning several species of *Papaver*. It appeared that most of these species regulate their numbers in response to increases in density of their own kind, independent of the density of other species. This forms an important mechanism in nature, which prevents elimination through crowding by neighbouring species.

Secondly, there may be a plastic reaction to density during the development of a plant. This response was illustrated by Harper with the following example, describing the growth of *Agrostemma githago* L. under various conditions of density and in different mixture situations. When grown in pure stand, the number of plants per unit area, which were produced from different amounts of seed, was fairly constant. All plants bore an approximately equal number of capsules and gave equal seed yields. In association with different species, however, the surviving plants bore an equal number of capsules but gave a different seed yield. Unmixed, the *Agrostemma* plants in the study gave about 30,000 seeds/sq.yd. In association with wheat, the same the number of plants produced about 12,000 seeds/sq.yd., and in association with sugar beets, about 22,000 seeds/sq.yd.

This type of response, when it occurs in a mixture of genotypes such as encountered in the early generations of a breeding program, could have important effects on the

outcome of selection. The occurrence of such interactions is suggested by observations made by Phung and Rathjen (1976, 1977), who reported that grain yield of wheat plants was affected by the frequency of plants of the same genotype, amidst a population of plants of a different genotype.

Genotypes in segregating populations of corn responded to changes in density with changes in seed yield (CIMMYT, 1972). They noted that density affected the selection of corn, and that different genotypes were selected at different plant densities.

A study of the effects of variation in spacing, seed size and genotype on plant-to-plant variation of wheat, showed that increased interplant spacing was by far the most effective in increasing plant-to-plant variation for characters, such as plant dry weight and yield components (Chebib et al., 1973). However, interaction between genotypes and variation in seed size also consistently, but insignificantly, increased variation among plants.

Contrary to the findings of Chebib et al., Kelker and Briggs (1978) observed a decrease in variance with increased spacing for several plant characters measured on seven cultivars of wheat. They concluded that the tendency for variance to respond to changes in spacing is cultivar specific, and that not all plant characters respond to the same degree.

Hozumi et al. (1955) used uniform seed of yellow dent corn to observe the growth of individual seedlings and their

response to neighbouring plants. The seeds were grown in boxes outdoors. They found that large plants in a row tended to suppress their neighbours, and vise versa, resulting in an alternation of large and small plants. This was clearly shown by auto-correlations of plant weights within a row. Correlations with first, third and fifth neighbours were negative, while correlations with second and fourth neighbours were positive. Plant weight in their study was estimated from stem diameter and plant height. The importance of plant shape to plant interactions was clearly illustrated by the observation that correlation coefficients of actual plant weight showed a similar pattern, but were much smaller. At wider spacing, the neighbour effects appeared to be restricted to first and second neighbours only (Yoda et al., 1957).

In an earlier paper by Kira et al. (1953), the authors found quite different results for the growth of soybean plants. In this study, an hexagonal planting arrangement was used, with equal distances between all plants. The correlation between the weight of an individual and the mean weight of the six nearest neighbours appeared to be positive rather than negative. The authors did not speculate on the reason for the observed behaviour. It can be noted, though, that while the corn experiment was performed in boxes, the soybean experiment was grown in the field where soil heterogeneity might have played a larger role. This would tend to create a positive correlation between neighbours

which were similarly affected by varying soil conditions. It is also possible that the different planting arrangement was responsible for the different results, because in rows, the effects of one plant are exerted onto two neighbours, while six neighbours are involved in the interactions between plants grown in hexagons. One can expect a proportional dilution of neighbour effects in this case, decreasing the strength of neighbour correlations.

Thus, because changes in plant density tend to change the time at which neighbour interactions start, one can expect neighbour interactions which are density specific. In a mixture of genotypes or species, the density of plants from the same genotype, as well as the density of plants from different genotypes may affect plant growth independently.

2.4.6 Changes in the distribution of characters during growth

The shape of the frequency distributions of various characters, assessed at different times during the growing season, is illustrative of the dynamic nature of the population. Mean and variance give only a partial description of the distribution curve. A more precise picture is obtained when skewness and kurtosis are included.

Skewness is a measure of asymmetry of the curve. A positively skewed distribution has a mean to the left of the median, and a 'heavy' positive tail (L-shaped). A negatively

skewed distribution has approximately a J-shaped form (Sokal and Rolf, 1969).

Kurtosis further specifies the shape of the curve. Generally, when no skewness is present, a positive kurtosis means that the character has more values around the mean and in the tails and less in the intermediate regions, than does a character with a normal distribution does. The curve is thus sharply peaked with flat long tails. A negative kurtosis, in the absence of skewness, indicates more values in the intermediate regions (Sokal and Rolf, 1969). However, many different shapes of curves may have similar values of kurtosis, and this parameter is not necessarily a measure of peakedness of the curve (Kendall and Stuart, 1977). Strongly skewed distributions tend to have a positive kurtosis, due to the heavy tail on one side of the curve.

Koyama and Kira (1956) pointed out that the frequency distribution of plant weight of many species was normal shortly after emergence, but became more positively skewed (L-shaped) with time. This effect was stronger at higher plant densities. On the other hand, plant height most often developed a distribution which was negatively skewed (J-shaped). The authors observed that higher mortality occurred in those stands which developed a skewed weight distribution during early growth, while in populations which kept a normal distribution, mortality was low. The two species for which height distributions were reported, corn and ragweed, both have a determinate growth habit. In these

plants, genetic factors impose an upper limit to plant height, while no lower limit is present. This could explain the J-shape of the distribution of height. No mention was made of a possible different shaped distribution for plants of an indeterminate growth habit.

Non-normal distributions were also observed on characters of barley, grown in simulated segregating rows at Beaverlodge, Alberta (H. A. Kelker, unpublished). The measured characters (the number of tillers, height, kernels per head and others) were those which are normally used as criteria for plant selection in a breeding program, and non-normality of their distribution could affect the accuracy with which superior genotypes are selected.

2.4.7 Effects of genotype interaction on grain filling and maturity

Although plant interactions can evoke responses in a great number of plant characters, the plant breeder is, ultimately, only interested in the final effect of these interactions on grain yield, and in many regions, on maturity.

Final crop yield of a high yielding dwarf wheat cultivar, Yecora, appeared to be well buffered against small reductions in crop photosynthesis at various times during the growing season (Fischer, 1975). Crop growth rate, on the other hand, responded to shading at any time. There are various phenomena which can explain the stability of crop

yield. For example, Fischer (1975) also observed that this cultivar adapts to variations in light intensity or plant spacing with variations in tiller survival. In this case morphological plasticity of single plants is related to stability of crop yield.

Another mechanism aiding the stability of crop yield was described by Evans and Wardlaw (1976). They reported that, of the dry matter which accumulates in grain on unstressed plants, 90 to 95% comes from photosynthates produced after anthesis. The remaining quantity comes from reserves stored in vegetative plant parts. Plants under stress from shading or defoliation, however, will draw upon reserves to a much greater extent.

Although actual grain filling does not start until several days after anthesis, shading immediately after anthesis had a significant effect on kernel weight of wheat (Ford and Thorne, 1975). Shading during this period affected the subsequent capacity of grains to accumulate carbohydrates, possibly through limiting the number of endosperm cells, or through a mechanism which limits the amount of carbohydrates that can be translocated. Shading during this period, however, did not affect the amount of nitrogen in the mature grains, thus resulting in grains with a relatively higher grain protein percentage (Jenner, 1979).

The negative correlation which exists between the number of kernels per plant and kernel weight (Fisher, 1975; Jenner, 1979), once more illustrates the mechanism through

which yield can be buffered against variations in individual yield components. Variations in the number of kernels per head were brought about by various degrees of shading in the period just prior to anthesis (Fischer, 1975). Adjustments in subsequent kernel size, however, could not completely compensate for the reduced number of kernels, and reductions in yield were observed as a result from pre-anthesis shading.

Effects of plant interaction on maturity have generally been overlooked in studies on mixtures of genotypes, possibly because visual assessment of maturity of single plants is generally inaccurate. More reliable measurements can be obtained from the moisture content of the grain as an indirect indication of maturity, although this is a very time consuming technique (Somerville, 1977).

One could, however, anticipate that genotype interactions may affect maturity of mixture components. For example, variations in the onset of flowering, related to varying levels of nutrients in the leaves, have been reported for several plant species (Aitken, 1974). Such a situation could arise from the unequal sharing of available nutrients by the components of a mixture. Variation in the onset of flowering may affect the timing of subsequent developmental stages. Somerville (1977) reported a high correlation between date of flowering and maturity for both wheat and barley.

2.5 Effects of interaction between genotypes on single plant selection

The need for early identification of genotypes which have good agronomic qualities and high yield was clearly demonstrated by Shebeski (1967). He showed with a theoretical example, that with advancing generations, the proportion of plants which can be expected to possess the best combination of genetic characters decreases very rapidly. Thus, selection should ideally take place in the F2 generation.

It is possible to select for a number of simply inherited traits, such as disease reaction or height, at an early stage of a breeding program (Sneep et al.,1979). However, characters which are influenced by many different internal as well as external factors, such as yield, cannot be correctly assessed on a single plant basis. McGinnis and Shebeski (1968) illustrated the ineffectiveness of visual selection for yield in an F2 generation of wheat. They compared the results of visual selection of single plants by three plant breeders, with the results of random selection. They found that there was no significant difference between the mean yield of the F3-progeny plots derived from randomly selected lines and derived from lines selected by plant breeders.

Because visual selection of single plants for yield *per se* is ineffective, several studies have dealt with the question whether selection for other characters would be

effective in increasing yield.

Rasmusson and Cannell (1970) found selection for the number of heads in two populations of barley to be as ineffective as selection for yield itself. Yield was reduced when selection was practiced for high number of kernels per head. Selection for high kernel weight was effective in increasing yield in one of the populations.

An increase in grain yield, associated with mass selection for large kernel size in wheat, was found by Derera and Bhatt (1972). This increase appeared not to be correlated in any way with quality characters, such as test weight, milling extract, wheat protein, flour protein and kernel hardness (Bhatt and Derera, 1973). Röbbelen (1979), however, explained that in the past, increased grain yields of many crops have led to a relative reduction in seed protein, which, in cereals, is mainly due to the increase of the endosperm relative to the embryo.

Morphologic and agronomic characters of 22 cultivars of wheat were studied by Nass (1973). He found that the yield per ear, the number of heads per plant, harvest index, and kernels per head were all positively associated with plot yield. Yield per head and heads per plot had the strongest associations, but because the yield per head and heads per plant are negatively correlated with each other, it would be difficult to select for both traits at the same time. Nass suggested that selection for moderate expression of these two characters could lead to increased yield.

Hamblin and Donald (1974) found no consistent correlations between yield per head and ears per plant in the F3 and the F5 generations of a barley cross. But they did find that tall F3 plants with long leaves tended to give low yields in the F5 generation. They suggested that the greater amount of interaction between genotypes which occurs in the F3 generation caused suppression of the higher yielding types, resulting in the observed negative correlation.

It was concluded from studies on barley that interactions between genotypes caused significant shifts in the expression of plant yield, heads per unit area, and the number of kernels per head, causing genotypes with a high yield potential to yield poorly (Wiebe et al., 1961). If yield in monoculture is the criterion for selection, the poorest rather than the best plants should thus be selected from the early generations.

In the past, yield improvements have been paralleled by a steady increase in harvest index, a character which appears to be relatively insensitive to variations in environmental conditions (Donald and Hamblin, 1976). However, this was an unplanned side effect, since no selection for harvest index was practiced. The question can be asked whether the effects would be reversible: would selection for high harvest index be accompanied by an increase in yield? From studies with F3 and F5 generation plants of barley, it was concluded that harvest index is not

predictive for yield from one environment (F3) to another (F5) (Hamblin and Donald, 1974). However, comparison of single plants of wheat, grown in pots in the greenhouse and in plots in the field, showed that single plant harvest index is a good predictor of crop yield in the field (Syme, 1972).

Selection for harvest index in the F2 generation of two wheat crosses doubled the grain yield per plant in the F3 generation (Bhatt, 1977). In addition, the positive correlation of yield with harvest index was enhanced. While selection for low harvest index resulted in a correspondingly low harvest index in the F3 generation , selection for high harvest index resulted in a population segregating for high and medium harvest index, thus allowing further selection for this character.

Although Donald and Hamblin (1976) reported that harvest index is relatively little affected by variations in density, resulting in a low genotype x density interaction, Nass (1980) found that indirect selection for grain yield through harvest index gave better results when practiced at commercial density than when practiced at low density. He ascribed this to the smaller plant-to-plant variation for harvest index which exists at high density.

The value of selection for harvest index was studied by Rosielle and Frey (1975a,b), using 1200 F9-derived lines of oats, grown in hill plots. They concluded that selection for harvest index alone was 43% as effective as was selection

for grain yield. If selection for height and maturity were combined with selection for harvest index, this percentage increased to 70%, indicating a good relationship between yield and harvest index within the limits of acceptable height and maturity, in homozygous lines.

Harvest index of main shoots appeared to be an even better indicator of crop yield. (Fischer and Kertesz, 1976). Using 30 genotypes of bread wheat, correlation coefficients were computed between the yield of plots at commercial crop spacing with harvest index of main shoots, harvest index of whole plants and grain yield of spaced plants, respectively. They obtained values 0.57 (sign., $\alpha = 0.01$), 0.49 (sign., $\alpha = 0.01$) and 0.20 (n.s.) respectively.

Because interaction between genotypes evokes reactions which are specific to each mixture situation, it is not surprising that Hamblin and Rosielle (1978) found great differences between genetic parameters of crosses when estimated in mixture and when estimated in monoculture. They demonstrated, using published data from different authors, that interaction between genotypes can increase or decrease the observed additive and dominance effects by a considerable amount. They showed cases where these parameters, measured in a monoculture and measured in a mixture, differed by more than 100%. In some cases, the values were about equal in magnitude, but opposite in sign.

In addition to an effect on the mean values of characters, positive and negative effects of plant

interaction on the variances were reported (Hamblin and Rosielle, 1978). As a result, estimates of heritabilty which are based on the estimation of variance components in a mixture of genotypes, would be either under- or over-estimated. 'This may lead to excessive effort being put into crosses and parents where competitive effects have increased heritability estimates and to the rejection of crosses and parents where they have reduced heritability estimates.' (Hamblin and Rosielle, 1978). The authors then suggested that, if early generation selection is to be effective, techniques should be developed which accurately assess the confounding effects of competition on the estimation of genetic parameters, and which could be used to correct these parameters for plant interaction effects.

In order to be able to assess the confounding effects of interaction between genotypes on the expression of genetic characters, it is necessary to know which plant characters are affected by genotype interaction, how interaction affects these characters and which characters of neighbouring genotypes are associated with these effects. The present study was conducted in an attempt to contribute fundamental knowledge on these subjects, focusing on the implications of genotype interaction for breeding of spring wheat.

3. Short Description of the Experiments

The experiments for this study were conducted during the growing seasons of 1977, 1978, and 1979, and were designed to investigate different aspects of the interaction between wheat genotypes.

During the first year of the study, eight genotypes and their binary mixtures were planted accurately at eight different interplant spacings. Morphologic characters were measured on single plants at maturity. It was hoped to learn from this test how the effects of competition were expressed at various spacings in each of the studied genotypes.

For the second year of the study, five of these genotypes were grown at three different spacings in monocultures and binary mixtures, and a detailed study was made of the relationships between plant characters of competing genotypes. Effects of interaction on mean plant performance as well as on plant to plant variation were determined.

During the last year of the study, the role of seed size and subsequent plant development on the development of adjacent plants in a row was investigated. This experiment involved only monocultures of the five genotypes used in the second year.

In addition to the single plant experiments, replicated yield trials, containing eight genotypes in monoculture and all possible binary mixtures, were grown in each of the three years. These tests were conducted to illustrate how

each of the genotypes affected mixture yields, and how the performance of mixtures varied over the three years.

4. Materials and Methods - General Information

The specific procedures followed for each of the experiments in this study are discussed in the sections preceding the presentation of the results for each test. General information pertinent to all the experiments is given in the following sections.

4.1 Characteristics of test sites

Experiments were conducted at the Edmonton Research Station in 1977 and in 1979, and at the Ellerslie Research Station in 1978. Both stations are operated by the University of Alberta, Edmonton, Alberta, Canada.

The sites are located about 10 km apart, at a latitude of 53° 24' N and at an altitude of 694 m above sea level. Appendix 1 shows the mean monthly temperatures and precipitation during the three growing seasons in which the experiments were conducted.

Both sites are located in the thin black soil zone and the soil is classified as silty clay loam.

Fertilizer was applied in each spring prior to seeding, at rates recommended for wheat, based on soil analyses conducted by the Soil and Feed Testing Laboratory of Alberta Agriculture (Appendix 2). During the fall of 1977 and 1978, Avadex was applied to the test sites for control of wild oats. In 1977 and 1978, herbicides were applied during the early stages of growth, for control of the common broadleaf

weeds, stinkweed, green smartweed, pigweed and hempnettle (Appendix 2). In addition, all plots were hand weeded when necessary.

4.2 Plant material used

Eight wheat genotypes were used in the test: Pitic 62, Glenlea, Park, Neepawa, 70M110001, 70M009002, Norquay and NB701. Park and Neepawa are Canada Western Red Spring wheats, while the other genotypes are Utility type wheats. The genotypes were chosen to represent a wide range of agronomic characters such as height, maturity, tiller number and seed size (Appendix 3). Seven of these genotypes had been previously studied, providing extra information on their performance at the Edmonton and Ellerslie test sites (Attinaw, 1977; Somerville, 1977).

As a seed source for Pitic 62, Glenlea, Park, Neepawa and Norquay, foundation seed or registered seed was used. For the genotypes 70M110001, 70M009002 and NB701, clean, sound seed was obtained from yield trials conducted as part of The University of Alberta wheat breeding program.

In each year, kernel weights and germination rate of all genotypes were determined on the seed lots to be planted (Appendix 4). Germination tests were conducted in petri dishes containing two rounds of filterpaper (Wattman, no. 40) and 4 ml of distilled water. The dishes, containing 100 seeds each, were placed in a Seedburo incubator, model 2100,

at 36°C, and germination was determined at 24, 48, 72 and 96 hrs.

5. Interaction Between Genotypes at Different Interplant Spacings

5.1 Materials and methods

5.1.1 Field plot design

During the first year of the study, monocultures and binary mixtures of the eight genotypes were tested over a wide range of spacings, to observe genotypic differences in response to variations in the environment.

Each of these mixtures and monocultures was grown at eight different spacings, ranging from 7 to 60 cm between plants. To make the most efficient use of space, a 'wheelplot' design was used, in which each wheelplot represented one mixture or monoculture grown at seven spacings. Seeds were placed on a grid made up of concentric circles and 'spokes', and seeds of the competing genotypes were alternated on the spokes and circles, such that each plant was surrounded by four plants of the associated genotype. In proceeding outward from the centre of the circle, the distance between plants increased as the spokes diverged, and the distance between concentric circles increased.

Plant density was calculated as the average of the distance from one plant to its four immediate neighbours, which were situated on either the same spoke or on the same

circle. The resulting spacings were 7, 9, 12, 15, 19, 24 and 31 cm between plants or 204, 124, 69, 44, 28, 17 and 10 plants per m^2 respectively. Commercial seeding rates in the Edmonton area range from 56 to 101 kg/ha (Alberta Farm Guide, 1976), which converts to approximately 140-250 seeds/m^2.

Each plot had the shape of a three quarter circle with a radius of 2 m, containing twenty four spokes and nine concentric circles. The plants on the innermost and outermost circles, as well as on the first and the twenty fourth spoke, were discarded as guard plants.

In addition to the seven spacings in the wheelplots, each genotype was grown in a rectangular plot, containing 10 plants each, planted at an equidistant spacing of 60 cm. At this spacing plant interactions were assumed to be absent.

5.1.2 Seed preparation and data collection

To reduce seeding time, all seeds were glued onto cotton string (10/6 S), made by Dominion Textile (Texmade), using LePage's Multi Use Bondfast. This method had previously been used in the field for several years with good success (Dr. V. Burrows, Chief, Cereal Section, Research Branch, Ottawa, Agriculture Canada, 1976; personal communication). To keep the 24 strings (spokes) of each plot separated, they were labelled and tied, in the order in which they had to appear in the field, onto a stake which at seeding time could be placed in the centre of the plot. A

strip of paper was subsequently placed on top of the strings and strings and paper together were rolled around a cardboard tube.

To facilitate placement of the strings in the field, a square metal frame was constructed, containing a bar which could rotate around a central axis. Furrows were drawn with a metal shoe which slid along this bar. After placement of the strings, the furrows were closed and packed using a board.

Before harvest, the location of each plant was recorded on plot maps and all plants were labelled. All plants which had all four neighbours present were harvested when 75% of the tillers appeared to be ripe. Measurements were taken on plant height, height of the flag leaf blade, the number of tillers, the number of fertile heads (heads with a minimum of five seeds), the number of kernels per plant, grain yield per plant, and above ground plant dry weight. From these measurements, the following characters were calculated: extrusion length (calculated as plant height - height of the flagleaf blade), the number of kernels per head, weight per 1000 kernels, the yield per head and harvest index (calculated as plant grain yield/ plant dry weight).

Because the present study approached the problem of genotype interaction as it is encountered by the plant breeder when he makes selections in the field, measurements of height and related characters were taken on two randomly chosen tillers of each plant. In this way it was hoped to

obtain a more realistic estimate of the variation which is observed in the field, than would be obtained from measurements on the main stem only.

5.2 Analysis of the data

The wheelplots were arranged according to a randomised block design with two replications which each occupied two banks of plots. The 60 x 60 cm spaced plants were replicated four times and grown at the end of each bank.

Because the spacing treatments were arranged systematically within the wheelplots, the requirements of randomisation were not met. The spacing effects indicated by the analysis of variance are thus confounded with effects due to treatment arrangement. The results cannot be considered as more than an indication of possible effects of spacing and will have to be further tested in subsequent experiments.

5.3 Results

Pitic 62 failed to germinate sufficiently and all treatments involving this genotype were dropped from the 1977 tests. Additional germination and or growth problems were encountered in the remaining plots, resulting in a very low number of usable plants overall. More than half of the plots (31 out of 56) had a survival rate of less than 75%. Recorded survival rate in some plots was as low as 43%,

while a few plots (including all 60 x 60 cm spaced plants) were abandoned completely.

In search for an explanation for the poor germination, soil tests were performed in the fall of 1977. The results indicated levels of available P ranging from 39 to 47 lb/2M on the east side of the field to 14 lb/2M along the west side of the field. Although no specific symptoms of P-deficiency were noted during the growing season, all but four of the sparsely populated plots were located in the western halves of the banks, suggesting a direct or indirect relationship between the phosphorus content of the soil and survival rate.

Seeding was interrupted by two days of heavy rain, causing some of the seeds to become uncovered, which probably added to the low germination rates in some plots.

In an effort to get as much information from the data as possible, the test was treated as a completely randomised design. Plants from both replicates were pooled, and only those treatments were included for which data had been recorded on a minimum of five plants. For none of the genotypes were data available from all possible genotype combinations (Appendix 5). Means and variances of the characters measured at each treatment illustrate the observed range of performance (Appendix 6). Since data about monoculture performance were obtained for only four genotypes (Glenlea, Park, 70M110001 and Norquay), tests for the effects due to genotype interaction had to be limited to

these four genotypes.

Spacing effects and genotype effects were significant ($\alpha \leq 0.01$) for all characters (Table 1). Mixing significantly affected height of the flag leaf, plant height, 1000 kernel weight and harvest index. However, interactions between effects of genotype interaction and spacing were significant for plant weight, yield and the number of kernels per plant, indicating that neighbouring plants affected these characters at some of the spacings tested. Interactions between the effects of genotype interaction and genotype were significant for all characters except the number of heads, the number of tillers, and kernels per plant, suggesting that the genotypes differed in their response to genotype interaction. Three way interactions were significant for the number of heads, the number of tillers, weight, yield, and the number of kernels per plant.

Comparison of mixture and monoculture performance of each of the four genotypes at each of the spacings tested, indicated the specific densities at which the various characters were affected (Table 2). While interaction - indicated by significant t-values - was evident for Glenlea at a density of 10 plants/m^2, Park was only affected at 124 and 69 plants/m^2 and 70M110001 only at 124 plants/m^2. None of the genotypes showed significant effects of interaction at 44 and at 204 plants/m^2. It is likely that at the highest plant density, the general effects of density on plant growth were so strong that the more subtle effects of

Table 1. The effect of genotype, genotype mixing, and interplant spacing on single plant characters, as determined by analyses of variance.[1]

All plants were grown in wheelplots in 1977, and measured at maturity. The data are only from plants which had all four neighbours present.

Source of variation	df	Mean squares of characters[2]											
		T	H	Wt	Y	FL	Ht	ExL	K/P	K/H	Y/H	Kwt	HI
Genotypes (G)	3	160.3**	96.2**	6645**	1162**	3510**	32504**	23481**	280477**	2665**	16.35**	2299**	0.191**
Mixing (M)	1	0.0	13.8	1135	109	505**	8859**	17	1264	360	1.16	444**	0.037*
Spacings (S)	6	1915.1**	907.2**	31510**	7103**	83**	346**	278**	3988200**	11672**	15.93**	153**	0.082**
G × M	3	7.1	19.0	1008*	237*	986**	3614**	201**	77860	1668**	4.46**	916**	0.118*
G × S	18	49.5**	46.7**	1035**	243**	22	50	37	74868*	341	0.67	18	0.015*
M × S	6	42.7	28.0	1062**	252**	22	41	19	98303*	610	0.56	59	0.009
G × M × S	9	40.3	41.0**	1183**	198*	34	83	40	83213*	263	0.96*	40	0.013
Residual	574	22.5	16.3	361	94	29	80	55	42857	325	0.46	42	0.009

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
2. Abbreviation of characters:

T = Number of tillers per plant
H = Number of fertile heads per plant
Wt = Plant dry weight
Y = Grain yield per plant
FL = Height of the flag leaf blade
Ht = Shoot length
ExL = Extrusion length
K/P = Number of kernels per plant
K/H = Number of kernels per head
Y/H = Grain yield per head
Kwt = 1000 kernel weight
HI = Harvest Index

Table 2. Comparison of the means of characters of single plants, grown in monoculture and in mixture, at various plant densities, by means of Students t-test.[1]

All plants were grown in wheelplots in 1977, and measured at maturity. The data are only from plants which had all four neighbours present.

Genotype	Density (plants/m^2)	df	t-values for measured characters[2]									
			Ht	H	T	Wt	Y	K/P	K/H	Y/H	Kwt	HI
Glenlea	204	22	0.54	0.21	0.31	0.71	0.00	0.19	0.48	0.91	0.24	2.24
"	124	33	1.28	0.06	1.27	0.58	1.07	1.14	2.37*	2.23*	0.52	1.76
"	69	33	1.01	0.63	1.66	0.90	1.88	1.63	2.46*	2.79**	1.89	1.85
"	44	27	1.44	0.71	0.94	0.29	0.37	0.24	1.16	0.98	0.09	0.92
"	28	18	0.51	2.23*	3.46**	2.47*	3.03**	2.86**	0.31	0.45	0.43	2.66*
"	17	18	0.71	1.04	0.06	0.13	0.44	0.55	2.81**	2.15*	1.09	0.80
"	10	17	0.57	0.29	1.37	0.73	2.39*	2.72**	2.23*	2.00	2.38*	2.15*
Park	204	23	1.39	0.13	0.17	0.40	0.52	0.33	0.71	0.97	0.89	0.66
"	124	39	1.59	2.01*	2.45*	1.62	1.77	1.86	1.16	1.22	0.67	1.35
"	69	30	3.54**	1.20	0.82	1.31	1.18	1.79	0.33	0.60	0.41	1.41
"	44	26	1.86	0.06	0.27	0.16	0.66	0.06	0.18	1.05	1.83	1.46
"	28	27	0.29	0.91	0.31	0.35	1.16	0.83	0.11	0.74	0.66	1.79
"	17	24	0.34	0.26	0.45	0.47	1.26	0.57	0.05	0.45	0.71	1.59
"	10	24	0.50	1.78	0.56	0.90	0.89	0.74	1.15	0.94	1.38	1.68
70M110001	204	23	0.20	0.28	0.22	0.25	0.73	0.54	1.72	1.98	0.40	1.82
"	124	20	0.93	1.37	2.09*	2.26*	2.31*	2.28*	1.43	1.78	1.01	0.88
"	69	21	1.86	0.60	1.66	1.51	0.20	0.59	0.28	0.85	1.63	1.15
"	44	25	1.19	0.28	0.40	1.11	1.64	1.54	0.95	0.27	0.25	0.44
"	10	17	0.78	0.35	0.77	0.90	0.92	0.91	1.55	1.59	0.00	0.45
Norquay	124	10	0.59	0.28	1.06	0.13	0.90	0.98	2.30*	2.29*	0.72	0.42
"	10	15	0.41	0.28	0.13	0.14	0.92	0.68	1.21	1.46	1.73	1.35

1. * significant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$

2. character abbreviations defined in Table 1.

interaction between different genotypes could not be distinguished with the experimental techniques used.

5.4 Discussion

Because the data used for the analysis of this test come from a small number of observations only, further experiments are necessary to verify the conclusions about the effects of plant interactions on the genotypes involved over the range of spacings tested. Nevertheless, a number of comments can be made regarding the observed effects.

The fact that the genotypes differed in their response to genotype interaction, and that each did so at different spacings, indicates that interpretation of mixing experiments performed with a limited number of genotypes and environments could lead to variable conclusions.

It appeared that Glenlea, which is the tallest, latest and most vigorous of the four genotypes, was the only genotype to show effects of genotype interaction at a density as low as 10 plants/m^2. Possible methods of interaction are restricted to light interception by neighbouring plants, and interaction between root systems. Since shading by neighbours only occurred during part of each day, interaction between root systems is probably the most influencial factor at this interplant spacing.

6. Relationships between Plant Characters Measured on Mixed Genotypes

6.1 Materials and methods

In 1978, a test was conducted to investigate, in more detail than in 1977, the phenotypic responses of genotypes to genotype interaction at different spacings. To keep the experiment managable, the number of genotypes had to be restricted to five: Pitic 62, Glenlea, Park, 70M009002 and Norquay. They were chosen, based on the 1977 yield trials, to represent a wide range of Average Mixture Efficiency (see Section 8.2, p.92), and for their recognisability in a mixture. They were grown in rows 30 cm apart, at plant spacings within rows of 1, 3 and 9 cm. This resulted in densities of 333, 111 and 37 plants/m^2. Seeds were glued onto strings as described in Section 5.1.2, and placed in furrows which were drawn with a pointed stick along a board.

A split plot design was used with three replicates. The main plot treatments were mixtures and monocultures, and the subplot treatments were spacings. The mainplots, which were 6 m long, were divided into three subplots of equal length. Each plot consisted of three rows of which only the middle one was sampled. Three plants at each end of each subplot were discarded as guards.

From both the 3 cm spacing and the 9 cm spacing, a random sample of six plants per genotype was taken at

maturity, using only plants which had both neighbour plants present. Measurements were taken on the height of the the flag leaf blade, the extrusion length (height above the flag leaf blade), the head length, the yield per plant, the number of kernels per plant, the number of tillers per plant, the number of fertile heads per plant, and plant dry weight. From these measurements were computed the number of kernels per head, the yield per head, the 1000 kernel weight and the harvest index. As in 1977, measurements on height and related characters were taken on a random sample of two tillers per plant.

It was the intention to examine the root distributions of the genotypes in mixture, and therefore the complete bulk yield test was replicated several times, so that enough extra plots were available for destructive soil core sampling. Unseasonably high soil moisture content, however, made it impossible to obtain good soil cores, and this objective was abandoned. Thus, extra plots were available, and tiller samples were taken from these at flowering and at the mid-dough stage. Measurements were taken on the flag leaf area, the height of the flag leaf blade, the tiller length, the extrusion length and the head length. Each sample consisted of a 1 m section of row, chosen at random from one of the middle rows of the plots. The samples taken at the two developmental stages were not replicated, so that differences between mixing treatments may be confounded with differences among plots. At each stage, sampling was

completed in one day, so that differences among the genotypes will reflect genotypic differences in rate of development.

6.2 Analysis of the data

Because it was not possible to accurately separate the plants which were grown at the 1 cm spacing, only data obtained from the 3 cm and the 9 cm spaced plants were included. The data were analysed to detect effects of genotype interaction on within genotype variation, as well as on mean plant performance.

Variance, skewness and kurtosis of the measured characters were computed for each sample, as well as for the combined mixture data for each genotype. Because significant deviations from normality occurred, Bartlett's test for homogeneity of variances could not be used, since this test is extremely sensitive to non-normality (Scheffé, 1959). Scheffé described an approximate test for the comparison of variances, based on the natural logarithms of the sample variances. This analysis was used to test the effect of genotype, genotype interaction and spacing on the variances of all characters.

Overall differences in variation between plants grown in monoculture and plants grown in mixture, were determined by means of a variance ratio F-test, using the mean variances of all genotypes grown in mixture and grown in

monoculture. For these comparisons the natural logarithms of the data were used (Lewontin, 1966).

Although the test was designed as a split plot, it was decided that an error term with more degrees of freedom was desirable, which would make it possible to detect smaller effects of genotype interaction than would be possible with a split plot analysis of variance. Therefore a randomised block analysis of variance was used to test the effects of genotype, spacing and genotype interaction.

Mixture efficiency was expressed for components of yield and plant weight, using the technique described by de Wit (1960), as the 'Relative Yield Total' (RYT):

where YAB and YBA are, respectively, the mean plant yields, or values of the character concerned, of the genotypes A and B when grown in association with each other, and YAA and YBB are the monoculture yields of the two genotypes. The expressions YAB/YAA and YBA/YBB are called the 'Relative Yield' (RY) of genotypes A and B, respectively, expressing the ratio of the yield of a genotype in mixture to its yield in monoculture. A value of 1 for the RY of a mixture component indicates that the effects of interaction between genotypes are not different from those which plants of the same genotype have on each other. A RY greater than 1 suggests that the associated genotype makes demands on the

environment which are either different from, or less than, those of the genotype under investigation. A RY of less than 1 indicates that interaction between the genotypes negatively affects the growth of the genotype in question, compared to its growth in monoculture.

A RYT of 1 would indicate effects of a compensating nature, or the absence of any effect on either of the components. A RYT greater than 1 suggests that the genotypes are, at least partially, occupying different niches, and thus are not sharing the same supply of resources. A value less than 1 indicates an antagonistic effect of one or both genotypes on their associate.

Both RY and RYT values were computed for mixtures and their components.

Since no simple test is available to determine whether RY or RYT values differ significantly from 1, they were evaluated with a t-test, comparing monoculture and mixture values. RY values were called significant if the difference between mixture and monoculture yield differed significantly from 0. Significance of the RYT values was determined using a t-test comparing expected yields as can be computed from monoculture values, with observed performance in mixture.

Within each individual plant, many characters are correlated. When investigating the relationships between competing plants, these within plant correlations can play a confounding role. Unfortunately, the number of genotype combinations in the experiment yielded an insufficient

number of degrees of freedom to investigate partial correlation coefficients between all characters of associated genotypes. Only correlations between character pairs have therefore been investigated. For this, multiple regression analyses were used, using indicator variables to correct for replicate effects (Steel and Torrie, 1980).

6.3 Results

During the growing season, two large bare spots, in which no plants grew, occurred in the plot area. Soil tests, performed after harvest to determine levels of available soil nutrients, soil pH and physical soil characteristics, did not reveal any abnormalities which could be related to the bare spots. All monoculture plots of Pitic 62 happened to be planted in these areas, so that no comparisons could be made between the performance of this genotype in monoculture and in mixture. Additional mishaps at harvest time resulted in the loss of several more treatments. For each genotype, mean values of the measured characters, when grown in monoculture and in mixture at 3 cm and at 9 cm spacings, are given in Appendix 7.

Although one can expect genotype interactions to affect flowering time and subsequent maturity of the mixture components (Aitken, 1974; Somerville, 1977), measurements of maturity on single plants were not made, because the methods available for rapid screening of a large number of samples

are generally inaccurate (Somerville, 1977). Many more replications would have been needed than were available. Visual assessment of genotype maturity in mixture, however, did not indicate any effects of genotype interaction, and no data on this character have been reported.

6.3.1 Effects of genotype interaction on plant-to-plant variation

An analysis of variance using the natural logarithm of the sample variances, showed no effect of genotype interaction on plant-to-plant variation in any of the characters (Table 3). Significant differences between genotypes occurred for variances of all characters except the number of tillers, the number of heads, kernel weight and harvest index, and changes in spacing affected the number of tillers, the number of heads, plant weight, yield, kernels per plant and extrusion length. When, for each genotype, the results of all mixtures were combined, however, variation was, on the average, greater in mixture than in monoculture for the number of tillers, plant weight and yield at the 3 cm spacing, and for kernel weight at the 9 cm spacing (Table 4). Harvest index, height of the flag leaf, extrusion length and height were less variable in mixture than in monoculture at the 3 cm spacing, while kernel weight, height, and extrusion length showed a lesser variability in mixture than in monoculture at the 9 cm spacing.

Table 3. Effects of genotype, genotype mixing and interplant spacing, on the variance[1] of single plant characters, as determined by analysis of variance[2].

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were measured at maturity.

Source of variation	df	Mean squares of characters[3]												
		T	H	Wt	Y	FL	Kwt	ExL	HI	FL	Ht	HL	ExL	Y/H
Genotypes (G)	3	0.66	1.13	4.13**	4.58**	2.29**	1.49	4.02**	0.16	2.33**	5.47**	2.78**	3.14**	5.40**
Mixing (M)	1	0.83	0.13	0.02	0.22	0.20	0.91	0.50	2.13	0.47	0.40	0.70	0.09	2.67
Spacings (S)	1	51.37**	54.88**	67.18**	66.95**	68.37**	0.85	1.19	0.03	0.01	0.17	0.44	2.74*	0.04
G × M	3	0.24	0.17	0.28	0.12	0.09	4.45*	0.22	0.27	0.72	1.60	0.93	0.47	0.17
G × S	3	0.97	0.38	0.62	0.57	0.75	0.92	0.17	0.00	1.11	2.04	0.20	0.30	0.47
M × S	1	0.95	0.08	0.01	0.04	0.01	0.01	0.13	0.49	0.18	0.02	3.16	0.72	0.01
G × M × S	3	0.59	0.33	0.34	0.36	0.20	0.48	0.15	1.92	0.36	0.18	0.10	0.40	0.22
Residual	66	0.57	0.48	0.44	0.43	0.46	1.46	0.95	1.21	0.59	0.83	0.70	0.67	0.87

1. The natural logarithm of the variances were used.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 1. HL = Head length.

Table 4. The effects of genotyp[illegible] and interplant spacing on the average variation among plants, of single plant characters, as determined by a variance ratio F-test[1].

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character[2]	Inter-plant spacing (cm)	Coefficient of variation[3]		F-values	
		Monoculture	Mixture	F_1[4]	F_2[5]
T	3	25.1	36.0	2.06**	2.01**
H	3	28.2	31.7	1.26	1.82*
Wt	3	29.5	37.6	1.63*	1.68*
Y	3	33.1	39.0	1.39	1.48
K/P	3	31.2	36.6	1.38	1.68*
Kwt	3	7.6	8.9	1.37	2.04**[6]
K/H	3	18.5	19.5	1.11	1.01
HI	3	12.1	8.4	2.08**	1.89**
Fl	3	14.7	13.3	1.22	1.28
Ht	3	12.2	9.5	1.64*	1 75**
Exl	3	17.5	14.8	2.08**	2.32**
HL	3	9.4	13.9	1.38	1.22

Character[2]	Interplant spacing (cm)	Coefficient of variation[3]		F-values	
		Monoculture	Mixture	F_3[7]	
T	9	35.6	38.7	1.18	1.16
H	9	38.0	38.9	1.05	1.51**
Wt	9	38.2	40.3	1.11	1.15
Y	9	40.3	42.3	1.10	1.18
K/P	9	40.4	41.6	1.06	1.29*
Kwt	9	5.3	10.0	3.56**	1.26
K/H	9	18.6	18.0	*1.06*	*1.18*
HI	9	8.8	9.0	1.05	1.15
Fl	9	13.0	13.4	1.06	1.01
Ht	9	9.2	9.0	*1.03*	*1.10*
Exl	9	11.5	11.4	*1.02*	*1.69***
HL	9	9.5	12.7	1.08	*1.04*

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$
2. Character abbreviations defined in Table 1. HL = Head length.
3. Averages of the coefficients of variation of four genotypes.
4. $F_1 = s^2$ (lnx, mixture)/s^2(lnx, monoculture), df(180,60)
5. $F_2 = s^2$(lnx, 9 cm, monoculture)/s^2(lnx, 3 cm, monoculture), df(60,60).
6. F-values given in italics are the reciprocal of the values defined in footnotes 4, 5 and 7.
7. $F_3 = s^2$(lnx, 9 cm, mixture)/s^2(lnx, 3 cm, mixture), df(175,180).

Values of skewness and kurtosis averaged over the four genotypes grown in mononculture and in mixture, are given in Appendix 8. For some characters, in particular kernel weight and harvest index at the 3 cm spacing and number of heads and kernel weight at the 9 cm spacing, skewness was stronger in mixture than in monoculture. Other characters, such as kernels per head and height of the flag leaf at the 3 cm spacing and height at the 9 cm spacing, showed a skewed distribution in monoculture and a near normal distribution in mixture. In most cases, the kurtosis was less in mixture than in monoculture, indicating that, in mixture, more values occurred in the intermediate regions, with a lower concentration of values around the mean and in the tails. An analysis of variance, performed on the values of skewness and kurtosis, did not detect any significant effects of genotype interaction. However, the values were based on samples of only six plants per replicate. An analysis based on larger numbers of plants would be necessary to draw more meaningful conclusions with respect to the effect of genotype interaction on skewness or kurtosis.

6.3.2 Effects of genotype interaction on the expression of various plant characters

Although it was demonstrated in the previous section that the distributions of most characters deviated significantly from normal, no suitable transformations were found to correct this. Analyses were thus performed on

untransformed data.

As expected, the genotypes differed significantly from each other for most characters (Table 5). Mixing of plants with individuals of a different genotype had a significant effect only on head length, on kernels per head and on yield per head. However, genotype x mixing interaction effects were significant for all characters except height of the flag leaf, plant height, kernels per head and harvest index, suggesting differences between the genotypes in their reaction to genotype interaction.

All characters except height and harvest index were affected by an increase in spacing, and replicate effects were significant for extrusion length, 1000 kernel weight and harvest index. Genotypes differed for most characters in their response to spacing, as indicated by the significant genotype x spacing interactions. Mixing x spacing interactions were only significant for weight and harvest index.

6.3.3 Relative performance of genotypes in mixture

To evaluate the effect of genotype interaction on each character in each genotype, RY values were calculated (Table 6), and the effects of genotype interaction were tested for significance with a t-test. It can be seen that Glenlea, in most cases, yielded better in mixture than in monoculture. This effect was associated with an increased number of heads, and to a lesser extent with an increased

Table 5. The effect of genotype, genotype mixing, and interplant spacing on single plant characters, as determined by analyses of variance[1]. All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present and which were measured at maturity.

Source of variation	df	Mean squares of characters[2]												
		T	H	Wt	Y	FL	Ht	ExL	HL	K/P($x10^{-3}$)	K/H	Y/H($x10^{2}$)	KWt	HI($x10^{3}$)
Genotypes (G)	3	5	24**	1794**	399**	9857**	16497**	1318**	320**	76**	4098**	2496**	5641**	58**
Mixing (M)	1	5	1	164	18	74	131	59	23**	15	528**	121**	36	2
Spacings (S)	1	1340**	953**	22031**	4338**	934**	19	1057**	40**	220**	3338**	932**	314**	1
Replications	2	2	1	2	5	29	41	119*	2	5	9	1	51*	8**
G × M	3	20	16**	444**	91**	11	77	202**	6**	36**	102	39*	67**	3
G × S	3	11	6	600**	106**	167*	42	89*	5*	23*	25	6	51**	6**
M × S	1	1	3	3	7	39	1	58	0	2	2	0	0	9*
Residual	467	5	4	73	15	48	30	33	2	8	46	12	14	2

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1. HL = Head length.

Table 6. Comparison of single plant characters of four genotypes, in monoculture and in mixture, at two interplant spacings, by means of 'Relative Yield' (RY) values[1,2].

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were measured at maturity.

Mixture	RY values for measured characters[3]											
	Y		T		H		KWt		Wt		K/H	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
Glenlea + Pitic 62	0.96	1.13	0.87	0.97	0.89	1.11	1.06	1.00	0.93	1.06	1.06	1.01
+ Park	1.23	1.66**	1.24	1.51*	1.16	1.67**	1.06	1.04	1.27	1.55*	1.02	0.97
+ 70M009002	1.21	1.20	1.07	1.24	1.11	1.24	1.04	1.04	1.19	1.17	1.07	0.95
+ Norquay	1.34*	1.37	1.21	1.34	1.17	1.54*	1.09	0.94	1.34	1.27	1.06	0.90
Park + Pitic 62	0.70*	0.62*	0.67*	0.60**	0.66**	0.66	0.93	0.98	0.68*	0.57**	1.15	0.93
+ Glenlea	0.64*	0.59**	0.81	0.78	0.78*	0.83	0.93	0.91	0.65**	0.60**	0.92	0.76**
+ 70M009002	0.74	0.71*	0.91	0.76	0.85	0.81	0.94	1.01	0.75	0.70*	0.92	0.88
+ Norquay	1.12	0.74	1.03	0.72*	1.00	0.77	0.98	1.01	1.09	0.74*	1.16	0.95
70M009002 + Glenlea	0.75*	0.82	0.97	0.91	0.97	0.98	0.94	0.94	0.75*	0.78	0.83*	0.89*
+ Park	0.82	1.00	0.90	0.90	0.91	0.95	0.97	0.98	0.83	0.97	0.91	1.07
Norquay + Pitic 62	--[4]	0.82	--	0.79	--	0.86	--	0.98	--	0.83	--	0.97
+ Glenlea	0.42**	0.87	0.77	0.89	0.73	0.91	0.89**	1.02	0.44**	0.89	0.67**	0.92
+ Park	0.87	1.12	1.18	1.18	0.99	1.16	0.99	1.01	0.85	1.12	0.87	0.95

Table 6 (continued)

Mixture	RY values for measured characters[3]											
	HI		Y/H		FL		Ht		ExL		HL	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
Glenlea + Pitic 62	1.00	1.08*	1.08	1.01	0.96	1.03	1.01	1.04	1.13	1.03	1.08	0.98
+ Park	0.94	1.07	1.07	1.00	0.94	0.07	1.01	0.97	1.15	0.97	1.07	1.00
+ 70M009002	0.99	1.02	1.10	0.98	0.95	1.03	1.02	1.03	1.17*	1.02	1.09	0.99
+ Norquay	0.97	1.11**	1.14	0.86	0.96	0.89	1.04	0.93	1.20*	0.98	1.05	0.96
Park + Pitic 62	1.05	1.09	1.17	0.92	0.98	1.00	1.04	0.96	1.11	0.90	0.97	0.87
+ Glenlea	1.00	0.98	0.91	0.70**	0.97	0.96	1.02	0.93	1.08	0.89	1.01	0.84*
+ 70M009002	0.98	1.03	0.95	0.88	0.92	0.95	0.98	0.94	1.08	0.92	1.01	0.92
+ Norquay	1.01	0.99	1.24	0.96	0.96	1.01	1.02	0.99	1.11	0.96	1.12	0.94
70M009002 + Glenlea	1.01	1.06	0.78**	0.83*	0.99	0.98	0.88	0.98	0.84*	1.01	0.88	1.08
+ Park	1.00	1.03	0.89	0.95	1.02	0.97	0.95	0.99	0.90	1.05	0.99	1.11
Norquay + Pitic 62	--	0.99	--	0.93	--	1.00	--	1.00	--	0.99	--	0.98
+ Glenlea	0.96	0.99	0.60**	0.94	0.90	1.01	0.88	0.98	0.87	1.04	0.88	1.00
+ Park	0.96	0.99	0.86	0.94	1.04	0.97	1.00	0.98	0.95	0.99	0.92	0.98

1. $RY = \frac{\text{character in mixture}}{\text{character in monoculture}}$, see Section 6.2.

2. * singificant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$.

3. Character abbreviations defined in Table 1. HL = Head length.

4. No data available.

kernel weight. At the 9 cm spacing, harvest index of Glenlea in two mixtures was significantly higher than in monoculture.

With one exception, Park yielded less in mixture than in monoculture. Reduction in yield was associated with a lesser number of heads per plant, and in one mixture with fewer kernels per head.

Data for 70M009002 were only obtained for two mixture combinations. Yield in combination with Glenlea was less than in monoculture at both spacings and was associated with a reduced number of kernels per head. The number of heads per plant did not show any change from the number in monoculture. Park did not significantly reduce the yield of 70M009002.

Data for Norquay in association with Pitic 62 were only available for the 9 cm spacing. Although yield was less than in monoculture, none of the RY values were significantly less than 1. At the 3 cm spacing, the performance of Norquay in the presence of Glenlea was poor, and the number of kernels per head and 1000 kernel weight were both significantly ($\alpha \leq 0.01$) reduced. RY for the number of heads per plant was, in spite of its low value (0.72), not significantly less than 1, due to the small number of observations for this treatment. Association with Park reduced the yield of Norquay at the 3 cm spacing and increased yield at the 9 cm spacing, but neither value (0.87 and 1.12) was significant.

Overall, Glenlea tended to produce RY values greater than 1 for plant weight, yield and components of yield, while values less than 1 were more frequent among the other genotypes. This suggests that Glenlea plants grown in mixture were able to utilise a greater amount of resources than when grown in monoculture. The other genotypes, in particular Park, were more often negatively affected by associated genotypes.

Relative yield totals, derived from the RY values, appeared to be close to 1 for most cases (Appendix 9). A graphic representation of the performance of plants grown in monoculture and in mixture further illustrates the effects of mixture components on each other. Figures 2a through 2e illustrate the relationship between the yields of the genotypes grown in binary mixtures, and their yields in monoculture. In these graphs the monocultures and mixtures are seen as a 'replacement series' (de Wit, 1960), with the proportions of the genotypes in mixture being 1:0, 0.5:0.5 and 0:1, respectively.

At the 9 cm spacing, the RYT of the mixtures Glenlea+Pitic 62 and Glenlea+Norquay was greater than 1, and in both cases, the mixture yield surpassed the yield of the better component grown in monoculture.

At the 3 cm spacing, none of the RYT values were greater than 1, suggesting a detrimental effect of genotype interaction on plant yield at this spacing.

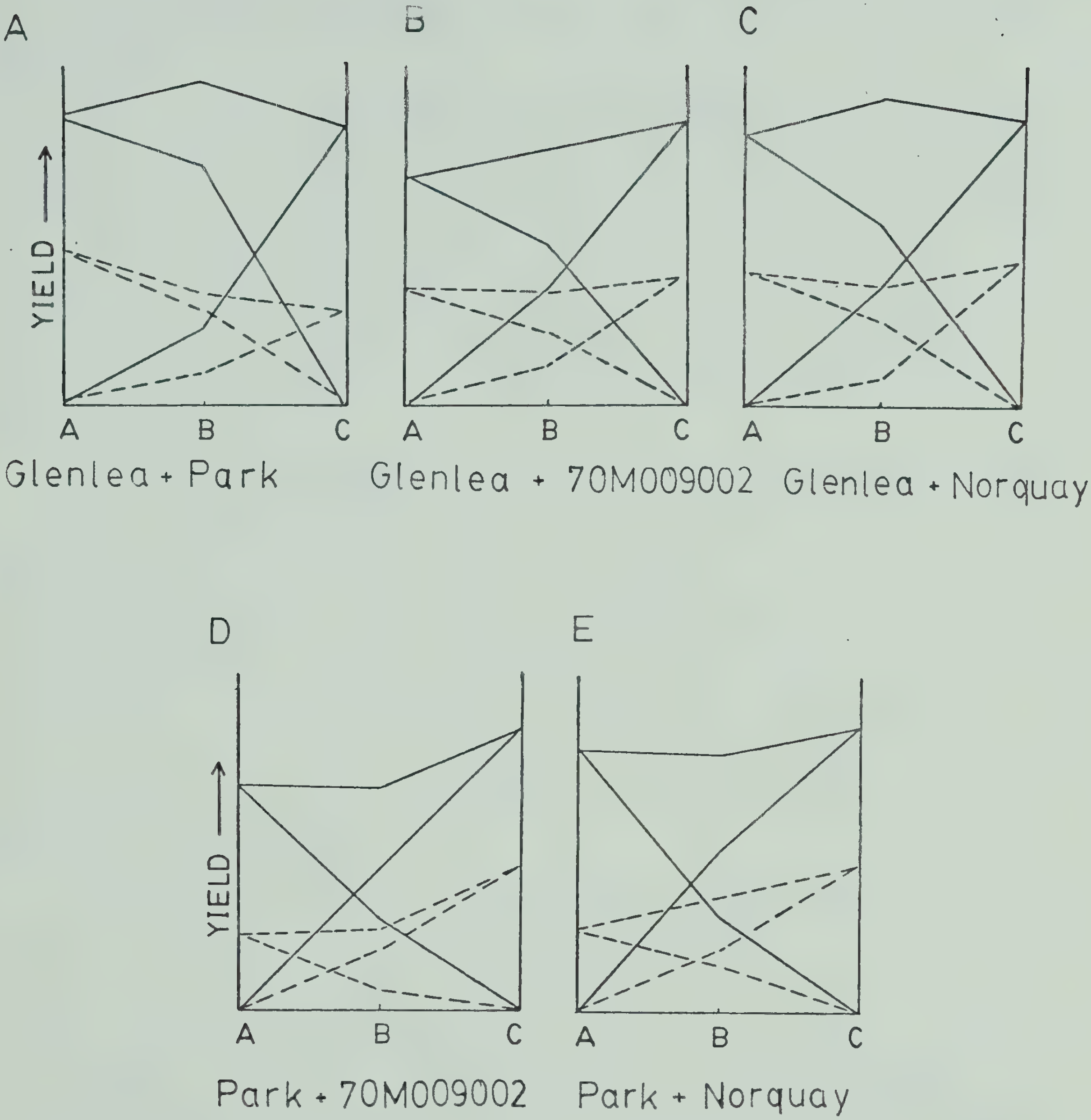

Fig. 2a-e. Graphic illustration of the genotype interaction effects on genotype and mixture yield in five genotype mixtures, each grown at two different interplant spacings in 1978. Along the X-axis, the populations containing 100% of the first genotype, 50% of each genotype, and 100% of the second genotype, are marked with the letters A, B and C, respectively.

6.3.4 Relationships between characters of interacting genotypes

One of the objectives of this study was to investigate the relationship between the measured values of characters on neighbouring genotypes. Correlations were therefore computed between the plant characters of each genotype in the test, and a number of characters of the associated genotypes (Table 7).

For most genotypes, the characters which played a role in plant interaction at the 3 cm and at the 9 cm spacings were not the same. Only Pitic 62 showed negative relationships of several characters with height of its associates at both spacings. In addition, the neighbour characters by which a genotype was affected differed from genotype to genotype.

Most characters of Pitic 62 were negatively correlated with the height of its associates. Since Pitic 62 was the latest maturing genotype in the test, and could throughout the growing season be identified in the field through its slow development, it is possible that this genotype showed more clearly the effects of interaction with taller neighbours, affecting plant weight, as well as grain yield and its components.

At the 3 cm spacing, most characters of Glenlea were positively associated with the weight and/or yield and the harvest index of its associates. Only tiller number was negatively related to the height of the associated

Table 7. Correlations[1] of single plant characters of five genotypes, with characters of associated mixture components, at two interplant spacings.

All plants were grown in four-row plots in 1978. The data pairs were averages of randomly selected plants, which had both neighbours present, and which were measured at maturity.

Char-acter[2]	Inter-plant spacing (cm)	Pitic 62 -[3]	Pitic 62 +	Glenlea -	Glenlea +	Park -	Park +	70M009002 -	70M009002 +	Norquay -	Norquay +
T	3	FL**	T*, H*	FL*, Ht*				HI**			
H	3	FL**, Ht*			T*			HI*			
Wt	3	FL**, Ht*	T*, H*							FL**, Ht*	
Y	3	FL*, Ht*			Wt*, Y*					FL**, Ht*	
K/P	3	FL**, Ht*	T*		T*					FL*, Ht*	
Kwt	3				Wt**, Y**			Ht*		FL*	
K/H	3	FL*			HI*, Y*	HI*		FL*		FL*, Ht*, ExL*	HI*
HI	3				ExL*, Ht*						
FL	3	Y**, Wt**						ExL*			
Ht	3	FL*						Ht*, ExL*			
HL	3	Y*, Wt*						FL*, Ht*		FL*, Ht*, ExL*	
ExL	3				Wt*, Y*, HI*	HI*		Ht*		FL*, Ht**	
Y/H	3	FL**, Ht*	T*		Wt*					Ht**, ExL*	
T	9	Ht*					H*	Wt*			
H	9						Wt*, Y*			HI*	
Wt	9	FL*, Ht**, ExL*		Y*, HI*	ExL *			Wt*, Y*			
Y	9	FL*, Ht**, ExL*			ExL *						
K/P	9	FL*, Ht*			ExL *		ExL*			HI*	
Kwt	9	HI*		HI**		FL*		T*		T*, H*	
K/H	9								ExL*		
HI	9	T*	FL**, Ht*					H*			
FL	9	ExL*						ExL*	H*		T*, H*, Wt*, Y*
Ht	9			Y*							
HL	9									HI*	T*, H*, Wt**, Y** ExL*
ExL	9			Y*, Wt*							
Y/H	9	FL**, Ht*						Y*			

1. * significant, α ≤ 0.05; ** significant, α ≤ 0.01.

2. Character abbreviations defined in Table 1. HL = Head length.

3. - negative correlations, + positive correlations.

genotypes. At the 9 cm spacing, however, weight, 1000 kernel weight, height and extrusion length of Glenlea were negatively correlated with yield, weight and harvest index of associated genotypes. It was earlier shown (Table 6), that Glenlea yielded better in most mixture situations than in monoculture. This could occur either if the demands of associates were less than those of Glenlea, leaving the latter a larger share of the available resources, or through 'hogging' of resources by Glenlea, resulting in suppression of the associated genotypes, accompanied by reductions in yield. RY values of less than 1, for the genotypes which were grown in combination with Glenlea (Table 6), support the latter hypothesis.

Park showed very few significant correlations at either the 3 cm or the 9 cm spacing. This could mean that either Park was not much affected by genotype interaction, or that Park was affected by its associates in an inconsistent manner. Since performance of Park in mixture was typically less than its performance in monoculture (Table 6), it can be concluded that Park responded differently to the various associated genotypes.

At the 3 cm spacing, many characters of both 70M009002 and Norquay were negatively correlated with the height of their associates, as was earlier described for Pitic 62. Unlike Pitic 62, however, these relationships did not exist at the 9 cm spacing. Pitic 62, 70M009002 and Norquay all have a medium height, but Pitic 62 tends to produce more

tillers (Appendix 7). It is possible that the tillers of Pitic 62 intermingle more with the tillers of neighbouring plants than do the tillers of the two other genotypes. This could result in effects of competition for light at both interplant spacings in mixtures containing Pitic 62, while for 70M009002 and Norquay, the increase in spacing from 3 cm to 9 cm was sufficient to reduce competition for light to an insignificant level.

Overall, it appears that competition for light plays an important role in the relationships between interacting genotypes, in particular for the shorter types and at the higher plant density. However, the negative correlations between the yield components of associated genotypes which occurred at the 9 cm spacing, indicate that competition for other growth factors did occur as well.

6.3.5 Interaction between genotypes during the early stages of growth

Mean values and standard deviations for characters measured on plants, grown in monoculture, at the flowering stage and at the mid-dough stage are reported in Appendices 10 and 11.

Again, correlations between characters of associated genotypes were calculated (Table 8). Positive correlations appeared to be more common than negative ones.

At the flowering stage, however, the flag leaf area of most genotypes appeared to be negatively correlated with

Table 8. Correlations[1] of single plant characters of five genotypes, with characters of associated mixture components, in machine seeded plots, at two growth stages.

All plants were grown in four-row plots in 1978. The data pairs were averages of randomly selected tillers.

Char-acter[2]	Growth stage[3]	Pitic 62 -[4]	Pitic 62 +	Glenlea -	Glenlea +	Park -	Park +	70M009002 -	70M009002 +	Norquay -	Norquay +
FL	F				ExL**, A**					ExL*	
Ht	F						A*			Ht**, A*	
A	F	ExL**, Ht*	A*		A*	ExL**, Ht**	A*	FL*		Ht**, A*	
ExL	F			ExL**					ExL*, Ht*		ExL**
HL	F	FL*, Ht**			ExL*, A*						
FL	M	ExL*					ExL*		ExL*		Fl*
Ht	M	ExL*									
A	M										
ExL	M							ExL*			
HL	M	ExL*									

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1. HL = Head length, A = Area of the flag leaf blade.

3. F = Flowering stage, M = Mid-dough stage.

4. - negative correlations, + positive correlations.

height components in associated genotypes. Variations in photosynthesis due to competition for light, or other factors correlated with height, could have affected leaf growth. This effect was not observed at the mid-dough stage, suggesting that leaf senescence, which sets in earlier in some genotypes, and in some plants within genotypes, than in others, caused a greater variation in the measurements of this character at flowering.

Plant height and height of the flag leaf of Norquay were negatively correlated with height of its associates at the flowering stage, but not at the mid-dough stage.

Overall, it appears that the effects of genotype interaction on the expression of the measured characters at both stages of growth were small. This might be partially caused by the greater amount of plant-to-plant variation which occurs in machine seeded plots than in plots with accurately spaced plants. Interaction associated with differences in height, however, appeared to occur at both stages of growth.

6.4 Discussion

6.4.1 Effects of genotype interaction on plant-to-plant variation

The variances of measurements of plants grown in monocultures and plants grown in mixtures were not

significantly different, possibly because a systematic planting pattern was used. A genotype, which is grown in a mixed stand in which two genotypes are alternated and accurately spaced within the row, will always have the same type of neighbours, even though these are different from neighbouring plants in a monoculture. This consistancy in neighbour relationships may explain the observed lack in variation.

Sakai (1955) observed that a genotype which tends to dominate in a mixture shows greater variation when grown in mixture with a less dominant type, than when grown alone or in combination with another dominating type. He did not discuss any changes in variation which could occur in a mixture of genotypes with an equal ability to dominate. One could, however, expect effects on within genotype variation which are related to the relative amount of random variation present in the two genotypes. A variable genotype, in combination with a uniform genotype, could conceivably show a reduction in variation, because the environment it experiences in such a mixture is more uniform than its environment in monoculture. Similarly, the other mixture component could show an increase in variation.

Any of these situations would result in a significant genotype x mixture interaction effect on plant-to-plant variation. In the present study, however, this interaction was only significant for 1000 kernel weight (Table 3).

When observing for each genotype the combined data from several binary mixtures, however, an increase in plant-to-plant variation was found for the number of tillers, weight and yield at the 3 cm spacing, and for kernel weight at the 9 cm spacing (Table 4). These effects may well be the result of the greater amount of environmental variation which is caused by the range of genotypes in the mixtures.

At both the 3 cm and the 9 cm spacing, the distribution of several characters, in particular kernel weight and harvest index, deviated significantly from normal. Although the analysis of variance is insensitive to small deviations from normality, other conclusions based on estimates of variation might be biased to a greater extent. The effect of non-normality on the expected gain from selection in a breeding program will be discussed in Chapter 9.

Chebib et al. (1973) found that in a mixture of segregating F3 lines of wheat, the effect of interaction between genotypes on plant-to-plant variation was insignificant for all measured characters. His results might be partially explained though, by the fact that he obtained his segregating population from a cross between the genotypes Pembina and Manitou, which have a similar genetic back ground[1], and therefore would produce a progeny which is

----

[1]Pembina=Thatcher x R.L.2564(R.L.2564=McMurchy-Exchange x Redman^{3})
Manitou=(Thatcher^{7}-Frontana x Thatcher^{6}-Kenya Farmer) x Thatcher^{6}-P.I.170925

genetically and morphologically much more uniform than the progeny from a more diverse cross would be.

Kelker and Briggs (1978) reported both increases and decreases in variation as a response to interaction of several genotypes. In their experiment, seven genotypes of wheat, including the ones used in the present study, were mixed within rows, simulating a segregating population. It was concluded that the tendency to increase or decrease in variation is genotype-specific.

The number of genotypes in the present study was not large enough to be able to verify Kelker and Briggs' conclusion, although the results from the present experiment do not disagree with their results. In Kelker and Briggs' study, the variation of the genotypes Glenlea, Park and 70M009002 each increased in varation due to genotype interaction at a density of 87 plants/ m^2, in particular for the characters heads per plant, yield and plant weight. In addition, variation for height of Pitic 62, Glenlea, and Norquay, and harvest index of Pitic 62, Glenlea, Park and Norquay decreased. Similar effects were observed in the present study (Appendix 7).

6.4.2 Effects of genotype interaction on mean plant performance

Significant changes in the mean values of several characters, related to either total plant weight or to plant yield, were observed, as a response to genotype interaction.

Harvest index, which is the ratio of plant weight and plant yield, was very little affected, illustrating the stability which a complex character can maintain in spite of the plasticity of its components.

For some genotypes, the response to genotype interaction was quite different at 3 cm and at 9 cm spacing. This was demonstrated most clearly by Glenlea, the characters of which showed positive correlations with most characters of neighbours at the 3 cm spacing, while negative correlations were more prevalent at the 9 cm spacing. Thus, a change in interplant relationships occurred with increasing plant spacing. A possible explanation is that at the 3 cm spacing, the available growth factors were limiting to both genotypes in the mixtures, thus preventing the expression of genotypic differences. At the 9 cm spacing, resources were less limiting and plants would have a greater chance to develop according to their genetic potential. This could have resulted in negative relationships between the measured characters of Glenlea and its associates at the 9 cm but not at the 3 cm spacing. this hypothesis is supported by the observation in 1977, that effects of genotype interaction were insignificant at the highest plant density, where all plants were severely reduced in growth.

Competitive interaction between plants frequently leads to negative correlations between characters of the genotypes combined in a mixture. However, positive correlations are observed as well. Interaction between plants of different

oat species, resulting in positive correlations between the height of mixture components, has been described by Trenbath and Harper (1973).

Factors which cause differences between replicates, such as soil heterogeneity or a difference in elevation, could also be the cause of a positive correlation between characters of genotypes which are combined in a mixture. In the present study, however, it was not possible to distinguish between positive correlations due to plant interaction and those due to other factors.

There is some evidence in the literature (Troughton and Whittington, 1968), that maturity is positively correlated with root mass, because late flowering plants can invest more time in the development of an extensive root system. If maturity is positively correlated with root mass, then Pitic and Glenlea, which were the latest maturing genotypes in this study, could have had a competitive advantage through a larger root system. This could cause negative correlations of other characters specific to these genotypes, such as the number of tillers or height, with the yield components of their associates. Whether this was the case can only be confirmed through studies involving measurements on the root systems during the growing season. This hypothesis could also explain why Park, which was the earliest genotype in the study, generally performed poorly in mixture.

At the 9 cm spacing, negative correlations existed between kernel weight and the number of tillers and the

number of heads on neighbours. These relationships suggest a different type of interaction than observed at the 3 cm spacing. Although interactions related to the greater nutrient requirements of plants with more tillers are probably of importance, one has also to consider the effect which variation in the number of tillers could have on the competition for light between neighbouring plants. It is possible that at the lower plant density, plants with many tillers interfere more with the light reception of their neighbors than do plants with less tillers, resulting in the observed correlations.

Interaction between genotypes in a mixture occurs throughout most of the growing season. In addition to measurements at maturity, a detailed study of the growth and development of each mixture component could therefore provide information on the causal basis for the observed results of interaction. Several studies have indicated that differences in the developmental pattern of neighbouring plants greatly influence their interaction (Christian and Gray, 1941; Trenbath and Harper,1973; Trenbath, 1975; Harper, 1977; Clark, 1980). The present study was not designed to perform such a detailed growth analysis. However, data collected at different times during the summer suggest that interactions occurring before flowering, and specifically those affecting growth of the flag leaf, may ultimately affect grain filling through an altered photosynthetic area (Hsu and Walton, 1971)

7. Effects of Seed Size on Plant Interaction

7.1 Materials and methods

In 1979, seed of the genotypes Pitic 62, Glenlea, Park, Norquay, and 70M009002 was sorted, through sieving and hand picking, into large, medium, and small size seeds (Appendix 12). The medium size seeds were discarded, and the rest seeded in plots, containing only large seeds, only small seeds, or small and large seeds alternated within the rows.

All seeds were glued onto strings (see Section 5.1.2) with 3 cm between seeds. The plots each consisted of three 2.5 m long rows, 30 cm apart, and all treatments were replicated three times. Eighteen adjacent plants (54 cm) from the middle rows were sampled at the 3-5 leaf stage, at the jointing stage, at the heading stage and at maturity. Since sampling at each time was completed in one day, the five genotypes were not at exactly the same stage of development.

The locations of the samples were randomised within each row, and two plants at the end of each sample were allowed as guards. At the time of sampling, all plants in the section of row to be harvested were numbered, and measurements were taken on each plant. Empty places in the row were recorded and plants with one or both first neighbours missing were discarded.

The characters which were measured varied with the time of sampling, as indicated in Table 9, and were chosen, for each developmental stage, as features which could easily be distinguished.

7.2 Analysis of the data

The data were analysed to investigate the effects of seed size and uniformity on plant performance, on within genotype variation, and on the interaction between neighbouring plants.

Variance, skewness and kurtosis of the measured characters were computed for each sample. The effects of genotype, seed size and uniformity on these parameters were examined for each sample date with an analysis of variance. Because several of the distributions of measured characters deviated significantly from normality, a natural log transformation of the variances was used (see Section 6.2)

Because plants were missing at the end of some rows, it was very difficult to identify the exact sequence number of each plant. This especially created a problem in the plots with mixed seed. It was, therefore, impossible to compare the performance of plants from large and small seeds in mixture, with the performance of the same type of plants in plots from uniform seed.

Differences between the genotypes, between the replicates, and between the performance of plants from

Table 9. Plant characters which were measured or derived at four stages of growth in 1979.

Measured Character	Abbreviation	Growth Stage[1]			
		1	2	3	4
Height (to tip of longest leaf) (cm)	Ht_1	x			
Height (of top most node) (cm)	Ht_2		x		
Height (to tip of head, including awns) (cm)	Ht_3			x	
Number of leaves	L	x			
Number of nodes	N		x		
Dry weight (g)	Wt	x	x	x	x
Number of tillers	T	x	x	x	x
Number of heads	H				x
Height of flag leaf (cm)	FL				x
Number of spikelets/head	Sp/H				x
Yield/plant (g)	Y				x
Number of kernels/plant	K/P				x

Derived Character	Abbreviation	Growth Stage[1] 1	2	3	4
Harvest Index = Yield (g)/Dry Weight (g)	HI				x
1000 kernel weight = Yield (g)/Number of kernels x 1000 (g)	Kwt				x
Number of kernels/head = Number of kernels/Number of heads	K/H				x
Extrusion length = Height - height of flag leaf (cm)	ExL				x

1. 3-5 leaf stage
2. jointing stage
3. heading stage
4. maturity

large, small, and mixed seed were examined, for each sample date, with an analysis of variance.

To investigate the interactions between adjacent plants from small, large, or mixed seed, simple correlation coefficients were computed for all character combinations on pairs of neighbouring plants (1st with 2nd, 2nd with 3rd, etc.).

It was intended to compute these correlations for second neighbours as well as for first neighbours. Missing plants, however, severely reduced the number of pairs for which correlations could be computed. For every plant which was missing, four of the first neighbour pairs and five of the second neighbour pairs were invalidated, or 23.5% and 31.3% respectively of the data. Since an average of 1.8 plants per plot were missing (10%), correlations on second neighbours have not been included.

In 1978, it was noticed that considerable variation in height existed among plants of the line 70M009002. At the end of the 1979 growing season, it became apparent that this genotype was not a pure line. There was a marked variation in height and awn length, and it was decided to eliminate this line from all tests involving single plant data. No meaningful comparisons concerning plant interactions can be made between treatments if there are already genetic differences in plant form, and possibly growth pattern, within the line under investigation. It is now believed that this line possessed a degree of outcrossing, perhaps as high

as 5%, which would explain the increase in heterogeneity as seed was increased during the three years of this study (Dr. K. G. Briggs, Professor of Plant Breeding, University of Alberta, Edmonton, Alberta, 1980, personal communication).

7.3 Results

7.3.1 Effects of seed size on mean plant performance and sample distribution of characters

Mean values of the plants from small seeds, from large seeds, and from mixed seeds, at each of the measured growth stages are shown in Appendices 13-16. Values of skewness and kurtosis of the samples are given in Appendix 17.

At the 3-5 leaf stage the plants from mixed seed had a significantly lower variance ($\alpha \leq 0.05$) for number of leaves than the plants from the uniform seed (Table 10). At maturity, only the variance of head length was significantly ($\alpha \leq 0.05$) affected by seed treatment. The head length of plants from small seed was much more variable than was the head length of plants from large or mixed seed.

The skewness and kurtosis of the characters within sample dates were not significantly affected by the treatments. However, distributions did differ significantly among growth stages for those characters which could be compared: the number of tillers, weight and height (sample 3, 4 only, Table 11). Kurtosis of all three characters was

Table 10. The effect of genotype and seed treatment[1] on the variance[2] of single plant characters, at different stages of growth, as determined by analyses of variance[3].

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters[4]	
		Number of leaves at the 3-5 leaf stage	Head length at maturity
Genotype (G)	3	9591	13978
Seed treatment (S)	2	15672*	24183*
Replicate (R)	2	667	14899
G × S	6	4458	6429
G × R	6	11539	7085
S × R	4	5445	7661
Residual	12	3729	6127

1. Seeds were sorted into large and small seeds (see Appendix 10) and seeded in rows with uniformly large seeds (treatment 1), uniformly small seeds (treatment 2), or large and small seeds alternated (treatment 3).
2. The natural logarithm of the variances was used.
3. * significant, $\alpha \leq 0.05$.
4. Characters which showed no significant differences have been excluded.

Table 11. The effect of growth stage, genotype, and seed treatment[1] on the variance[2] and skewness of single plant characters, as determined by analyses of variance[3].

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of distribution parameters				
		Variance			Skewness	
		Ht[4]	T	Wt	Ht	T
Growth stage (GS)	3	12.48**	25.68**	554.14**	3.26	5.14*
Genotype (G)	3	2.03**	4.80**	1.23	0.36	2.16*
Seed treatment (S)	2	0.11	0.68	1.87	1.08	0.29
Replication (R)	2	0.26	0.72	0.82	0.10	1.04
GS × G	9	2.51**	1.07	3.13	0.33	0.66
GS × S	6	0.76	0.53	1.82	1.55	1.05
GS × R	6	0.26	0.29	0.59	2.60	0.72
G × S	6	0.57	0.44	1.49	1.62	0.24
G × R	6	1.07	0.40	1.74	0.35	1.93
S × R	4	0.51	0.56	4.39*	1.68	0.76
Residual	12	0.47	0.57	1.71	0.85	0.79

1. As defined in Table 10.
2. The natural logarithm of the variances was used.
3. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
4. Character abbreviations defined in Table 1.

unaffected by growth stage, as was skewness of the weight distribution. However, the skewness of the distribution of tiller number changed significantly ($\alpha \leq 0.01$) from an, on the average, negative value at the first three sample dates, to a positive one at maturity (Appendix 17).

The skewness of the height distribution increased from an average value of -0.34 at the heading stage, to a value of -0.69 during the last part of the growing season (Appendix 8). Although the difference has only a significance level of $\alpha = 0.057$ it does illustrate the increase in skewness which was earlier observed by Koyama and Kira (1956).

At each growth stage, differences among genotypes were significant for most characters (Table 12a through d). At the first three growth stages, the genotype x treatment interactions were more often significant than were the treatment effects. This suggests that genotypes were affected differently by the various seed treatments throughout the growing season. At maturity, the seed treatment main effects and the genotype x seed treatment interactions were predominantly insignificant, as were the seed treatment effects. Height and dry weight, which had shown significant seed treatment effects at the jointing and at the heading stage, did not show these effects any longer. Because maximum height was not obtained by most plants until after heading, this disappearance of seed treatment effects illustrates the tendency of plants to grow out to a uniform

Table 12a. The effect of genotype and seed treatment[1] on single plant characters, measured at the 3-5 leaf stage, as determined by analyses of variance.[2]

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation		df	Mean squares of characters[3]			
			Ht_1	L	T	Wt (x 10^3)
Genotypes	(G)	3	322**	0.28	8.31**	5**
Seed treatment	(S)	2	10	0.82	0.97	3
Replicates	(R)	2	47**	4.46**	0.68	2
G × S		6	23	2.16**	2.77**	3*
G × R		6	58	1.39**	1.45	4**
S × R		4	1	6.87**	1.47	1
G × S × R		12	31	2.02**	1.74**	3*
Residual		392	12	0.32	0.70	1

1. As defined in Table 10.
2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
3. Character abbreviations defined in Table 9.

Table 12b. The effect of genotype and seed treatment[1] on single plant characters, measured at the jointing stage, as determined by analysis of variance.[2]

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation		df	Mean squares of characters[3]			
			Ht_2	N	T	Wt
Genotypes	(G)	3	147**	11.21**	12.29	3.24**
Seed treatment	(S)	2	61*	0.26	6.99	0.58
Replicates	(R)	2	78**	12.03**	3.39	1.74**
G × S		6	51**	2.03**	4.56	0.62*
G × R		6	36*	0.84	7.42	0.44
S × R		4	116**	2.05**	5.55	0.38
G × S × R		11	63**	2.12**	3.77	0.46
Residual		315	17	0.45	4.90	0.28

1. As defined in Table 10.
2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
3. Character abbreviations defined in Table 9.

Table 12c. The effect of genotype and seed treatment[1] on single plant characters, measured at the heading stage, as determined by analyses of variance.[2]

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters[3]		
		Ht_3	T	Wt
Genotypes	3	18462**	68.7**	1.69
Seed treatment	2	200**	0.7	9.63*
Replicates	2	187**	12.7*	2.08
G × S	6	270**	13.0**	9.77**
G × R	6	45	7.5	3.34
S × R	4	283**	6.1	7.07*
G × S × R	12	134**	7.5*	3.57
Residuals	383	28	4.0	2.67

1. As defined in Table 10.
2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
3. Character abbreviations defined in Table 9.

Table 12d. The effect of genotype and seed treatment[1] on single plant characters, measured at maturity, as determined by analysis of variance[2].

All plants were grown in three-row plots in 1979. The data are from consecutive plants in a row, excluding plants with missing neighbours.

Source of variation	df	Mean squares of characters[3]						
		Ht_3	T	H	Wt	Y	K/P(x 10^{-2})	HI(x 10^3)
Genotypes (G)	3	15437**	73.9**	55.1**	1297**	339.6**	2156**	73**
Seed treatment (S)	2	34	11.7*	9.4*	48	10.7	145	3
Replicates (R)	2	51	14.1*	14.6**	58	10.4	145	1
G × S	6	66	5.0	4.6	85	20.6*	153*	3
G × R	6	17	5.5	5.2	84	12.9	77	7**
S × R	4	42	11.4**	4.6	28	4.8	55	4
G × S × R	12	69	10.4**	7.2**	100*	10.3	84	7**
Residual	404	59	3.4	2.9	50	40.6	58	2

Source of variation	df	Mean squares of characters					
		Kwt	K/H	Fl	ExL	Sp/H	HL
Genotypes (G)	3	4557.6**	3582**	8409**	5606**	11.2**	508.1**
Seed treatment (S)	2	42.9**	43	30	10	0.4	0.6
Replicates (R)	2	115.2**	184*	38	25	11.6**	0.7
G × S	6	7.1	94	94	15	1.1	3.7
G × R	6	19.5*	44	46	11	4.4*	16.9**
S × R	4	13.0	55	6	15	3.1	7.3*
G × S × R	12	15.6*	103*	71	4	2.1	8.4**
Residual	404	8.9	56	47	17	1.7	3.0

1 As defined in Table 10.

2 * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

3 Character abbreviations defined in Table 9.

height, which is characteristic of their genotype.

The mean tiller number per plant dropped from jointing to maturity, for all genotypes except Park (Appendices 14 through 16). Tiller number was not significantly affected by seed treatment at the jointing and the heading stages, a significant genotype x seed treatment interaction ($\alpha \leq 0.01$) occurred at the heading stage, and at maturity, a significant treatment effect ($\alpha \leq 0.05$) existed for the number of tillers and the number of heads per plant (Table 12b through d).

At maturity, the plants from small seeds had fewer tillers and heads than did the plants from large seeds, for all genotypes except Glenlea (Appendix 16). Since seed treatment effects earlier in the season were not significant, this suggests that plants from small seed on the average lost more tillers than did plants from large seeds. Thousand kernel weight of the plants from large seeds was significantly smaller ($\alpha \leq 0.01$) than that of the plants from small seeds (Table 12d).

7.3.2 Effects of seed size on interaction between neighbours

The correlations of all measured characters of each plant with those of their first neighbours gave an unwieldy total of 1572 correlation coefficients. It would be of little value to look at the magnitude of each of these coefficients individually. More important is to see if any patterns in character relations exist. If no correlation

exists between two characters of neighbouring plants, the probability that the coefficients for all four genotypes in a treatment will be of the same sign just by chance is 1 x 1/2 x 1/2 x 1/2 = 0.125. Therefore, the value of the coefficients does not have to be very high to be meaningful, if they all have the same sign. In order to accept the hypothesis that a correlation exists between characters measured on neighbouring plants, in each of the four genotypes given the same treatment, with $\alpha \leq 0.01$, each of the coefficients has to have the same sign and a significance level less than or equal to 0.47, since 2 x $(0.47)^4 = 0.01$. Using this value, all correlation coefficients were examined for each of the three treatments (Table 13).

Throughout development, positive correlations were more common than negative ones. As was explained in Section 6.4.2, plant interactions as well as environmental conditions can be responsible for this. Conditions which affect a short section of row, such as variation in depth of sowing, wheel compaction or irregular nutrient distribution, could result in higher or lower values for all plants in that section, compared with plants in the rest of the plot, and, thus, result in positive correlations between neighbours.

At the jointing stage, the only negative correlation was the one between tiller number and the number of nodes of neighbouring plants, derived from mixed seed sizes.

Table 13. Correlated[1] characters of neighbouring plants, at different stages of growth, in rows of plants from large seeds, small seeds or alternated large and small seeds.

All plants were grown in three-row plots in 1979. The data are from overlapping pairs of neighbouring plants in a row: $1^{st}+2^{nd}$, $2^{nd}+3^{rd}$, $3^{rd}+4^{th}$, etc.

Growth[1] stage	Character[3]	Correlated (+, -) characters of neighbouring plants[4]		
3-5L	Ht_1	$+Ht_1 2$,	$+Ht_1 3$	
3-5L	L	$+Ht_1 3$,	+L1,	+L3
3-5L	Wt	$+Ht_1 3$		
J	Ht_2	$+Ht_2 1$,	$+Ht_2 2$	
J	N	$+Ht_2 1$,	+N1,	+N3
J	T	+N1,	-N3,	+T1
J	Wt	$+Ht_2 2$,	+N2	
H	Ht_3	$+Ht_3 1$,	$+Ht_3 2$	$+Ht_3 3$
H	T	+T2,	-T3	
H	Wt	$+Ht_3 1$,	$+Ht_3 2$,	+Wt2
M	Ht_3	$-KWt_3$		
M	T	-HI1,	-KWt1	
M	H	-HI1,	-KWt1	
M	K/H	-KWt1		
M	HI	+HI1		
M	KWt	+KWt1		

1. All correlations are significant with $\alpha \leq 0.01$.
2. 3-5L = 3-5 Leaf stage, J = Jointing stage, H = Heading Stage, M = Maturity.
3. Character abbreviations defined in Table 9.
4. Last number indicates seed treatment as defined in Table 10.

At the heading stage, the tiller numbers of neighbouring plants, derived from mixed seed, were negatively correlated. However, at this stage, tiller number of some genotypes was affected by seed treatment also (Table 12c), and the observed correlation, therefore, does not necessarily imply the occurrence of neighbour interactions. At maturity, a significant negative correlation existed between the number of tillers and harvest index and between number of heads and harvest index of plants from large seeds, and between height and 1000 kernel weight, and between stem length and 1000 kernel weight, of plants from mixed seed. Since seed size effects on tiller number, head number and kernel weight were observed in plots seeded to uniformly sized seed, one would expect negative correlations between these characters, in plots from mixed seed sizes. Their absence indicates possible effects of neighbour interaction. For plants derived from small seeds, significant correlations were all positive.

7.4 Discussion

The drop in tiller number, which was observed after heading for plants from all seed treatments, was more severe for plants from small seed than for those from mixed or large seed. This resulted in significantly fewer tillers and fewer heads on plants from small seeds at maturity.

For most genotypes, however, yield per plant was not significantly affected by seed treatment. The larger 1000 kernel weight, observed for plants derived from small seeds, demonstrates compensation for the reduction in head number, through an increase in seed weight. A number of factors could have contributed to this result. Firstly, some of the assimilates which were acquired before anthesis, and which had been stored in the lost tillers may have been relocated and later been used in grain filling on the remaining tillers (Evans and Wardlaw, 1976). Secondly, since competition for light takes place between leaves rather than between plants (Donald, 1961), leaves of plants with few tillers could experience less competitive interference from leaves on other tillers than would leaves on plants with many tillers, given the same interplant spacing. A higher rate of photosynthesis per leaf could therefore occur in plants with few tillers, resulting in more assimilates per tiller and, thus, the potential for larger kernels.

The data from this test give only partial support to the findings of Hozumi et al. (1955), who found negative correlations between dry weights and between shoot lengths of neighbouring corn plants derived from uniform seed. Negative correlations did occur in the present experiment, but not very frequently. The negative correlations which were observed among plants from large seed, all occurred between tillers or heads per plant and those characters which pertain to grain filling (harvest index, 1000 kernel

weight). This suggests that variation in tiller number is, directly or indirectly, related to the process of grainfilling in adjacent plants. No negative correlations showed up in the plots from small seed. This could possibly be the result of smaller root systems, which would reduce interaction between neighbouring plants.

Although alternating height differences between neighbours existed throughout the growing season in all three treatments, at maturity only the mixed seed treatment showed significant effects related to differences in height. It was not possible to determine with certainty whether small seeds gave rise to short or tall plants. If one assumes the former, than seed size in the mixed seed treatment had an effect on kernel weight opposite to the effect observed in the uniform seed treatments. The negative correlation, which occurred in the mixed seed treatment between height and kernel weight, suggests that plants from small seed with tall neighbours yielded seeds with low kernel weight and vice versa. Thus, interaction between the tall and short plants affected plant growth in such a way that tall plants were able to acquire a relatively greater amount of one or more of the factors limiting to grain filling. It thus appears that interactions between neighbours derived from different size seeds, were different than those which occurred between plants from uniform seeds, affecting in particular the character kernel weight.

The results of the present experiment indicate that differences in seed size can be a source of variation among phenotypes, both through effects on plant development as well as through effects on neighbour relationships. Although these conclusions are based on observations in monocultures, similar effects can be expected in a mixture of genotypes. Effects of interaction between genotypes in a segregating population might thus be confounded with the effects of seed size which occurred among the seeds of the propagated lines.

8. The Relationship Between Mixture Yield and Monoculture Yield of the Components.

8.1 Materials and methods

Yield trials were grown in 1977 and 1979 in Edmonton, and in 1978 in Ellerslie. The trials involved eight genotypes (see Section 4.2), grown in monoculture and in all possible binary combinations, arranged in a randomised block design with three replications.

Plots consisted of four 6 m long rows, spaced 23 cm apart, in banks which were separated by 2 m wide pathways. The rows were seeded in all three years in a N-S direction, guard plots were seeded at the end of each bank, and at harvest, a 30 cm strip at both ends of each plot was removed. Only the center two rows of each plot were harvested with a small plot harvester[1]. Using a visual assesment of maturity, each plot was harvested when more than 50% of the plants appeared to be ripe.

To obtain an equal number of plants of each genotype per plot, percent germination and 1000 kernel weight of each genotype were used to calculate the weight of seed necessary to give an average density of 257 seeds/m², or an average of 1.7 cm between seeds within rows. For an average weight of 40 g/1000 kernels, this seeding rate is equivalent to 100 kg viable seed per ha. These are similar seeding rates and

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[1]Designed and produced by J. Fitzsimmons and T. Snider, Dept. of Genetics, University of Alberta, Edmonton, Alberta.

plant spacings to those normally used for standard yield trials of wheat at both stations.

The plots were seeded with a small-plot disk seeder, designed in 1970 by the Canadian Department of Agriculture, Swift Current, Saskatchewan. A cone-shaped seed divider was attached to partition the seed equally into the four drill rows.

Harvesting conditions in 1978 were very wet, causing some loss of yield and considerable lodging in one corner of the field. Because the amount of loss was hard to estimate, the data have not been adjusted. None of the genotypes was infested with significant levels of disease or insect pests in any of the three years.

8.2 Analysis of the data

It was the objective of this study, to observe the stability of mixture yield over years, and to investigate the relationship between mixture yield and the yield of their components grown in monoculture.

By means of a randomised block analysis of variance, the variation among years, among monocultures, among mixtures and between mixtures and monocultures was examined.

From the yields of the monocultures in each block (replicate), the expected yield of each mixture in the same block was calculated as:

$$Y(AB)=Y(A)+Y(B)/2$$

where Y(AB),Y(A) and Y(B) are the plot yields of the mixture of genotypes A and B, and their monocultures, respectively. The ratio of the observed yield and the expected yield of a mixture of two genotypes, hereafter referred to as Specific Mixture Efficiency (SME), was calculated as:

using the same notation as above. If, for example, a mixture of the genotypes A and B has a plot yield of 1400 g, and the monoculture plot yields of A and B are 1000 g and 1500 g, respectively, then the SME of the mixture AB would be 2x1400/(1000+1500)=1.12.

The SME resembles the RYT which was used in Chapter 6. The RYT, however, is calculated from the RY of each of the components, and hence, will have values which are numerically slightly different from the SME values. The meaning of values less than one, greater than one, and equal to 1 is the same for both, however.

Significance of the SME values was tested with a t-test analoguous to the one described for RYT (see Section 6.2).

Spearman's rank order correlation coefficients were computed for the correlations between grain yield of the mixtures and SME in each of the three years, as well as for the correlations between yields in 1977 and 1978, yields in 1977 and 1979, and yields in 1978 and 1979, respectively. The same correlations were computed for the SME values.

Mixtures of two genotypes can be seen as analogues of the F1 generation of a genetic cross, and hence, techniques similar to those which are used to determine genetic parameters, can be used to analyse mixture properties. An analysis of variance for diallel crosses was developed by Hayman (1954). In his method, the total variation is partitioned into a component due to 'arrays' (columns of the diallel table), a set of three orthogonal interaction components, and an error term. Morley Jones (1965) described the use of this technique to analyse data from a half diallel.

Hayman's technique of diallel analysis has been modified and used by various authors to analyse competition experiments (Williams, 1962; Eberhart et al., 1964). In most of those cases, the competing individuals could be readily identified, allowing data to be collected from each of the components of the mixtures. Hay (1974) described the use of Hayman's analysis of variance for experiments in which the competing individuals cannot be separated.

The components of variation in the Hayman analysis are:

1. The array sum of squares, with n-1 degrees of freedom for an n x n diallel. Each column of the full diallel table comprises an array. The examination of the arrays of a half diallel thus requires that each data point is used twice in the computation. Morley Jones (1965) computed the SS for arrays as follows:

where Yr. is the sum of the rth array and Yrr is the value of the rth monoculture (diagonal values of the diallel table). Significant differences among the arrays would indicate that differences exist between the general ability of the genotypes to perform in a mixture.

2. An interaction term, b, which can be partitioned into three orthogonal components:
   a. b1 tests the effect of genotype interaction and allows examination of the difference between mixtures and monocultures, with 1 degree of freedom.
   b. b2 tests the differences between genotypes in their interaction with all other genotypes. The sums of squares are computed using for each array the differences between twice the mixture values and the monoculture values:

      Using the same notation as above, b2 has n-1 degrees of freedom. If no interactions between genotypes occur, this component measures strictly the differences in yielding ability among genotypes.
   c. b3 tests the effect due to specific combinations of genotypes and is computed by subtraction of the SS's for arrays for b1 and b2 from the total SS.

The formula which was used by Morley Jones for array SS, was used by Griffing (1956) to test differences in General Combining Ability (GCA). He used the remaining variation as a whole, to determine effects of specific combining ability (SCA). The use of Griffing's technique for the analysis of mixture experiments was suggested by Jensen and Federer (1965). Hayman's partitioning of the interaction SS, however, allows a closer examination of the types of interaction which take place and of their relative magnitude.

GCA is a parameter which was originally introduced to assess the value of a genotype for breeding purposes. An extensive review of this subject was given by Sprague and Tatum (1942). Because high yield is an objective of most breeding programs, an indicator of both yielding ability of a genotype and its value as a parent in crosses, is useful for the selection of breeding material. In experiments which study the mechanisms underlaying mixture efficiency, however, the yield of a mixture is only of interest in relation to the monoculture yields of its components. Average Mixture Efficiency (AME) can be expressed as the ratio of the observed mixture yields to the mixture yields which can be expected based on the monoculture yields of the mixture components:

using the same notation as before. If, for example, binary

mixtures are formed from the genotypes A,B, and C, and the monoculture plot yields are 900 g, 950 g, and 1000 g, respectively, and the mixture plot yields are 1000 g each, the AME for genotype A would be
$2x3000/(3x900+900+950+1000)=1.09$.

The AME provides a measure of the average effect of a genotype on mixture yield, using its monoculture yield as a point of reference. The GCA gives an indication of a genotype's ability to perform in mixture using the experiment mean as a point of reference.

Jinks (1954) suggested the use of regression of the covariances (W) of offspring and parents of a diallel cross on the variances (V) of the offspring, to investigate dominance relationships. Harper (1965) and Hill and Shimamoto (1973) used a similar technique to determine the genotypic differences in 'competitive ability' of plants grown in mixtures. For the analysis of mixture experiments, the positions of the array variances along the X-axis of the resulting graph indicate the ability of the genotypes to dominate in the mixture. Dominating types will influence the performance of the mixtures in which they grow to a larger extent than will less dominating types, resulting in more uniform array components. Their arrays are, therefore, expected to have smaller variances and covariances. As a result these values will lie near the origin of the graph. Without any specific interactions between genotypes, a regression line can be fitted with a slope of approximately

1. Deviations from 1 will result from mixtures which perform much better or much worse than expected, causing an increase in variance and a decrease in covariance.

If a linear relationship exists between V and W, the sum (W + V) can be correlated with the monoculture yields (or any other character that might play a role in genotype interaction) to determine whether there is an association of monoculture yield with the ability to dominate in a mixture.

For the analysis of variance of the mixture yield trials from 1977,1978 and 1979, Hay's directions (1974) were followed. Regression lines of W on V were fitted according to Jink's method (Jinks, 1954). SME and AME values were computed, and for comparison, Griffing's (1956) formula was used to compute the effects of General and Specific Combining Ability (GCA and SCA) for each genotype or genotype combination. In order to assess the significance of the AME values, a t-test was used to compare the observed mixture yield with the expected yield based on monoculture values. Significance of the GCA values was tested with an F-test, using MS values obtained from the analysis of variance. Correlations between monoculture yields and AME were computed, to investigate the relationship between AME and yielding ability.

8.3 Results

In spite of satisfactory performance in the 1977 germination test (84.7%), Pitic 62 failed to germinate in the field that year, and in 1977, all plots involving this genotype had to be discarded.

Monoculture and mixture yields varied substantially in the three years (Appendix 18a through c). Besides the different locations involved, the weather patterns in the three years were quite dissimilar (Appendix 1), which probably contributed to these yield differences.

The yield levels of the mixtures, in relation to those of the component monocultures, were divided into the following four categories (Table 14):

1. below the monoculture yield of the lower yielding component in that year (C1),
2. between the monoculture yield of C1 and the mean of the component monoculture yields (C2),
3. between C2 and the monoculture yield of the higher yielding component (C3), and
4. above C3.

Significantly ($\alpha \leq 0.05$) more than half of the mixtures yielded more than the mid-component yield, suggesting, on the average, a greater efficiency of resource utilisation by mixtures than by monocultures in these three years. However, only 4 of the mixtures (14.3%) yielded more than the mid component yield in all three years. None yielded consistently less.

Table 14. Frequency distribution of mixture yield relative to the yield of the components grown in monoculture.

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Mixture	Frequency distribution of mixture yield[1]			
	$Y_M<C_1$	$C_1<Y_M<C_2$	$C_2<Y_M<C_3$	$Y_M>C_3$
Pitic 62 + Glenlea				2
Pitic 62 + Park			1	1
Pitic 62 + Neepawa			1	1
Pitic 62 + 70M110001				2
Pitic 62 + 70M009002				2
Pitic 62 + Norquay	1			1
Pitic 62 + NB 701				2
Glenlea + Park			1	2
Glenlea + Neepawa			2	1
Glenlea + 70M110001		2		1
Glenlea + 70M009002		1		2
Glenlea + Norquay			2	1
Glenlea + NB 701	2			1
Park + Neepawa	1		1	1
Park + 70M110001	1	1	1	
Park + 70M009002	1		2	
Park + Norquay		1	1	1
Park + NB 701	1		1	1
Neepawa + 70M110001	1	1	1	
Neepawa + 70M009002		1	2	
Neepawa + Norquay	1	1		1
Neepawa + NB 701		1		2
70M110001 + 70M009002	1	1	1	
70M110001 + Norquay		2		1
70M110001 + NB 701	1		2	
70M009002 + Norquay		2		1
70M009002 + NB 701		2	1	
Norquay + NB 701			1	2
	11	16	21	29
Percent of total	(14.3)	(20.8)	(27.3)	(37.7)

1. Number of seasons in which the mixture yield (Y_M) fell in the specified categories; where

   C_1 = Lower yielding component

   C_2 = Mid-component yield

   C_3 = Higher yielding component

2. Data for Pitic 62 were only obtained in two years.

8.3.1 Effects of genotype interaction on plot yields

An analysis of variance of the combined data of the three test years showed that year effects as well as effects among mixtures and monocultures were significant ($\alpha \leq 0.01$) (Table 15). Partitioning of the treatment SS into components containing variation due to differences among monocultures, due to differences among mixtures and due to differences between mixtures and monocultures, revealed that mixture and monoculture yields did not differ significantly when observed for a period of three years. Significant interaction effects existed beween years and mixtures and between years and monocultures, suggesting a year effect on the performance of individual genotypes when compared in mixture and in monoculture.

Analysis of each year individually (Table 16) revealed the absence of significant differences between monocultures in 1978. This fact is probably largely responsible for the year effect reported in Table 16. The wet fall weather in 1978 caused considerable lodging in one corner of the field, which resulted in a significant ($\alpha \leq 0.01$) replication effect, and probably obscured true genotype effects. The differences among mixture yields were significant in each of the three years ($\alpha \leq 0.05$, $\alpha \leq 0.01$, $\alpha \leq 0.01$). Only in 1977 did mixture and monoculture yields differ significantly ($\alpha \leq 0.05$).

Table 15. The [illegible]t of year, genotype monoculture and genotype mixing on plot yield, as determined by analysis of variance.[1]

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Source of variation	df	Mean square
Years (Y)	2	2913881**
Treatments (T)	27[2]	26432**
Genotype		
Monocultures (Mono)	6	51901**
Mixtures (Mix)	20	18963*
Mix vs Mono	1	22990
Y × T	54	33183**
Y × Mono	12	45503**
Y × Mix	40	30069**
Y × Mix vs Mono	2	21547
Residual	168	11487

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
2. Data for Pitic 62 have been excluded for all years.

Table 16. Th... of genotype monoculture and genotype mixing on plo... ..eld in each of three test years, as determined by analyses of variance.[1]

All plots were machine seeded, and harvested at maturity, in 1977, 1978 and 1979.

Year	Source of variation	df	Mean square
1977	Treatments:		
	Genotype		
	Monocultures (Mono)	6	68725**
	Mixtures (Mix)	20	21543*
	Mono vs Mix	1	60896*
	Replications	2	22021
	Residual	53	10846
1978	Treatments:		
	Genotype		
	Monocultures (Mono)	7	22197
	Mixtures (Mix)	27	29860**
	Mono vs Mix	1	6513
	Replications	2	138430**
	Residual	107	12336
1979	Treatments:		
	Genotype		
	Monocultures (Mono)	7	48808**
	Mixtures (Mix)	27	43720**
	Mono vs Mix	1	14597
	Replications	2	3242
	Residual	107	8682

1. * significant, $\alpha \leq 0.05$, ** significant, $\alpha \leq 0.01$.

8.3.2 Mixture efficiency and its correlation with yield

Both the mean mixture yields and SME values differed from year to year. For example, the Park/Neepawa mixture yielded well above the expected yield in 1977, while in 1979, the yield of the same combination failed to reach even the level of the lower yielding component (Appendix 18a through c).

Spearman's rank-order correlation coefficients were computed for the following correlations (Table 17):

1. mixture yield and SME in 1977, in 1978 and in 1979,
2. mixture yields in 1977 and 1978, in 1977 and 1979, and in 1978 and 1979, and
3. SME's in 1977 and 1978, in 1977 and 1979, and in 1978 and 1979.

No consistent relationship seemed to exist between the mixture yields and the SME values in any of the three years. The relative mixture yields in 1978 appeared to be quite different from those in 1977 and in 1979, and either climatic conditions or the different location could have influenced relative yields.

Attinaw (1977) grew seven of the eight genotypes which were involved in this study, at three different locations, including Edmonton and Ellerslie. Table 18 shows the rank order for yield, in each year, for the genotypes grown in his study and in this study at the two locations. Some genotypes appeared quite consistent in their relative position (e.g. Glenlea and Park), while others were more

Table 17. Relationship between mixture yield and Specific Mixture Efficiency[1], within and between years, as expressed by Spearmans rank order correlation coefficient[2].

Correlated Parameters[3]	Correlation coefficient
Y_{77} - Y_{78}	-0.37*
Y_{77} - Y_{79}	0.58**
Y_{78} - Y_{79}	-0.29
Y_{77} - SME_{77}	0.19
Y_{78} - SME_{78}	0.26
Y_{79} - SME_{79}	0.74**
SME_{77} - SME_{78}	-0.21
SME_{77} - SME_{79}	0.29
SME_{78} - SME_{79}	0.06

1. As defined in Section 8.2.
2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.
3. Y_{77}, Y_{78}, Y_{79} = mixture yield in 1977, 1978 and 1979, respectively.

   SME_{77}, SME_{78}, SME_{79} = Specific Mixture Efficiency in 1977, 1978 and 1979, respectively.

Table 18. Rank orders of the monoculture yields of eight genotypes, and the mean yields of their mixtures, as observed at the Edmonton and Ellerslie locations.

Genotype	Rank orders							
	Monocultures					Mixtures		
	1975[1] Edmonton	1977[1] Edmonton	1979[2] Edmonton	1975[1] Ellerslie	1978[2] Ellerslie	1977[2] Edmonton	1978[2] Ellerslie	1979[2] Edmonton
Pitic 62	1	--[3]	1	1	5	--	4	1
Glenlea	4	4	3	3	4	5	2	3/4
Park	7	7	8	7	7	6	7	7
Neepawa	5	6	6	5	1	7	1	8
70M110001	2	3	5	2	2	3	3	5
70M009002	3	1	4	6	8	1	8	2
Norquay	6	2	7	4	3	2	5	6
NB 701	--	5	2	--	6	4	6	3/4

1. Data from Attinaw (1977)
2. Data from present study
3. Genotype not represented in test of that year

unstable (e.g. 70M009002). In 1978, however, the genotypes Neepawa and Pitic 62 showed quite a different relative yield level than in any of the other years. This erratic behaviour also determined the performance of the mixtures containing these two genotypes, as illustrated by the ranking of the array means. The variable yields obtained from both monocultures and mixtures over the three years thus appear to relate to factors other than the change in location.

8.3.3 Diallel analysis of variance

As was discussed in Section 8.2, analysis of the data as a mixture diallel allows a more detailed interpretation of the results.

Array means differed significantly in each of the three years ($\alpha \leq 0.01$)(Table 19). In the absence of interaction effects between the genotypes, this is a reflection of genotype differences in yielding ability. In the previous section it was shown, however, that in 1978, the differences among genotypes in monoculture were insignificant. A significant array effect in this year, thus, suggests the occurrence of a significant interaction between genotypes in mixture in that year.

The b1 effect, which contrasts mixture and monoculture yields, was significant in 1977 only ($\alpha \leq 0.05$), indicating that interaction between genotypes was present in that year also. Only in 1979 was the b2 effect significant ($\alpha \leq 0.01$), indicating that the effects of genotype interaction on yield

Table 19. The average array and specific effects of genotype on mixture yield, as determined by diallel analyses of variance[1] for each of the three test years.

All plots were machine seeded, and harvested at maturity.

Year	Source of variation[2]	df	Mean square
1977	Replications	2	22021
	Arrays	6	100804**
	Mixtures vs monocultures	1	60896*
	Average genotype interaction	6	7519
	Specific genotype interaction	14	13805
	Residual	53	10846
1978	Replications	2	138430**
	Arrays	7	176335**
	Mixtures vs monocultures	1	6513
	Average genotype interactions	7	6901
	Specific genotype interaction	20	18877
	Residual	70	12336
1979	Replications	2	3242
	Arrays	7	168180**
	Mixtures vs monocultures	1	14597
	Average genotype interaction	7	27834**
	Specific genotype interaction	20	7501
	Residual	70	8682

1. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Sources of variation were partitioned according to the technique described by Hayman (1954); see Section 8.2.

differed among genotypes.

Hay (1974) explained that, when the additions made by the interactions to the array values (mixtures) are correlated with the diagonal values (monocultures), '...the differences between the arrays will be inflated and the array mean square will be more likely to reveal interactions than the b2 mean square.' It can be noted, though, that this is only the case if the correlation is positive. In the present study, the correlation between monoculture yield and Specific Mixture Efficiency was insignificant in two of the three years, and significantly positive ($\alpha \leq 0.01$) in the third year (Table 17). Simmonds (1962), however, investigated the relationship between the difference between mixture yield and mean monoculture yield, and the mean monoculture yield of the components, and reported a negative corelation. Thus, a positive correlation cannot be considered to be a general rule.

The b3 effect, which measures variation due to specific mixtures, was not significant in any of the three years, suggesting that no specific combination of genotypes performed exceptionally well or exceptionally poorly in any of the three years.

8.3.4 Mixture efficiency

The AME values for each of the genotypes in each of the three years show the ability of each genotype to perform in a mixture situation (Appendix 19). The values for GCA, which

merely reflect the relative yield level of the mixtures in the test, were computed for comparison. Slight discrepansies between the rank order for array mean yield and for GCA are due to the fact that monoculture yields are used twice in the computation of GCA and once in the computation of the array mean yield.

Great variation existed from year to year among AME values of each genotype. In 1977, all genotypes had AME values greater than 1, suggesting a contribution to the mixture yield which is greater than expected from monoculture values. In 1978, however, less than half the genotypes seemed to perform better than expected in mixture.

Correlation coefficients of AME with monoculture yield for the three years were insignificant (Table 20), and it can be concluded that no consistent relationship existed between monoculture yield and the ability to perform in a mixture.

8.3.5 Regression of W on V

The regression of the covariances (W) of the array values and monoculture values (diagonal values of the diallel table) on the array variances (V), provides information on the relative ability of the genotypes to dominate in mixture (Figure 3). Because the genotype Pitic 62 was eliminated from the 1977 tests, the values for that year are not directly comparable with the other years.

Table 20. Simple correlations (r) between monoculture yield and Average Mixture Efficiency[1], in 1977, 1978 and 1979.

Year[2]	r
1977	-0.48
1978	-0.05
1979	0.57

1. See Section 8.2
2. Seven genotypes were used in 1977, eight in each of the years 1978 and 1979.

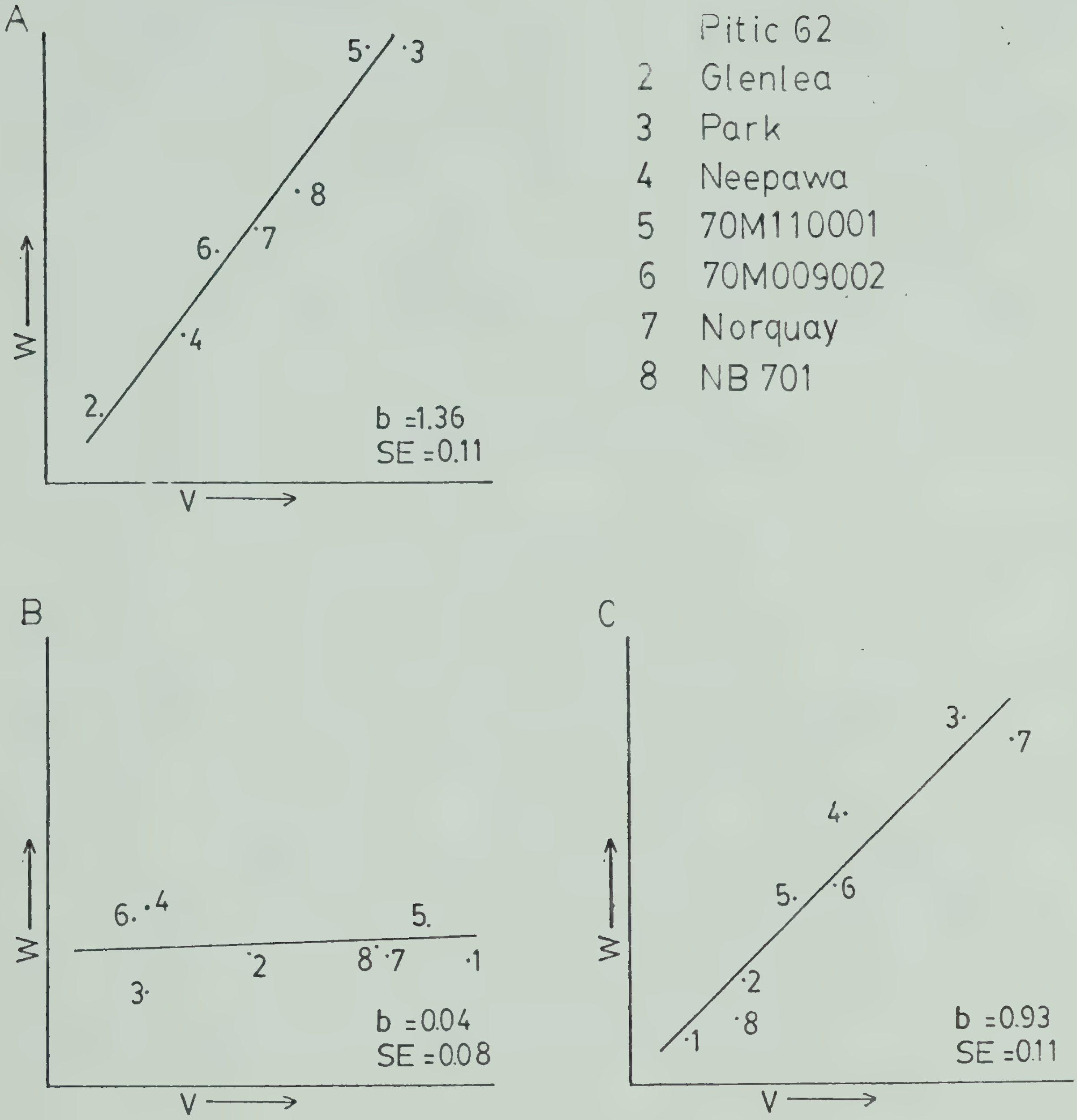

Fig. 3a-c. V-W regression lines, illustrating the relative ability of genotypes to dominate in a mixture, in the years 1977, 1978 and 1979. V = variance of the array (mixture) values, W = covariance of the array values and the diagonal (monoculture) values.

As was already shown by the previous analyses, in 1978 the behaviour of the mixtures was erratic. Although the slopes of the regression lines in 1977 and 1979 were both close to one, the ranking of the genotypes according to their behaviour in mixture was quite different in each of the years. Glenlea, 70M009002, Neepawa and Park generally maintained their positions, while 70M110001, Norquay and NB701 showed quite different behaviours in mixture in the two years.

The V-W regression line shows along the x-axis the genotypes in order of their dominance in the mixtures. Correlation of the rank-order of dominance in mixture of the genotypes with their monoculture yields, resulted in a Spearman's rank-order correlation coefficient of 0.25 (n.s.) for 1977 and of 0.99 (sign $\alpha \leq 0.001$) for 1979 (Figure 3).

It can thus be concluded that the ability to dominate in a mixture was highly variable from year to year and not consistently related to yield in monoculture.

8.4 Discussion

It has been suggested that the ability to perform well in a mixture is negatively correlated to yield in monoculture (Wiebe et al., 1961; Simmonds, 1962). The present study, however, did not support this theory. Significant differences existed in every year in the relative ability of the genotypes to dominate in mixture. No

relationship was found between the ability to dominate in mixture and monoculture yield in the same year.

Baker (1977) reported variable results for Neepawa, Pitic 62, and a mixture of the two, and ascribed this to the fact that Pitic 62 was better able to compensate for poor survival after early drought conditions, when grown in pure culture than when grown in combination with Neepawa.

DePauw et al. (1981) included the same genotypes in a study comparing yield at five locations over four years. They also found great variation in the performance of the genotype Pitic 62. They ascribed this to frost damage in the post-anthesis stage. In the present study, however, neither post-anthesis frost nor early drought occurred in any of the three years.

It is probable that the different responses of the genotypes to the variable climatic conditions were responsible for the year to year variation. Identification of genotype-specific responses to the environment, however, would require a qualitative study of genotype-environment interactions.

The results of this experiment do support the findings of those investigators who concluded that mixtures, on the average, yield more than the expected mean of the component monocultures (Table 14). This suggests that a positive interaction can occur between the components of a mixture, resulting in a more efficient use of available resources by one or both of the mixture components. Variation within and

between years, however, was so large that the yield advantage of mixtures over monocultures was statistically insignificant (Table 15). No specific binary mixture was identified which consistently gave a high yield advantage.

9. Discussion of the Results with Respect to Single Plant Selection in Early Generations

Inefficiency of single plant selection in early generations can be ascribed to two major sources of error:

1. The amount of additive genetic variation present in the population is low, which makes it difficult to identify those genotypes which harbour the superior genetic material one wishes to select.
2. Effects of genotype x environment interaction on plant growth can cause undesirable phenotypic variation.

The relative magnitude of these factors is expressed by the heritability (H^2) of a character, which is computed as follows:

$$H^2 = \text{Genetic variance} / \text{Total variance}$$

Estimates of heritability can be obtained in a variety of ways, and the outcome will vary with the experimental design used and the method of computation employed (Allard, 1960; Falconer, 1960). Experiments with a large number of replications will reduce the environmental variance and, thus, give higher estimates for H^2. However, single plant selections from early generations have to be made from unreplicated plots, and the improvement of the selected population over the parental population depends entirely on how accurately superior genotypes can be identified within those plots.

9.1 Effects of non-normal character distribution on single plant selection

The expected gain from selection can be expressed as

where k is the selection differential, which takes into account the mean and the variance of the parental population, the mean of the selected fraction, and the selection intensity; .. is the phenotypic standard deviation; and H^2 is the heritability of the observed character (Allard, 1960). This expression assumes a normal distribution of the units to be selected, whether they are mean values of characters of plants grown in rows or observations on single plants. Reports on non-normal distributions of several characters of various plant species were given by Koyama and Kira (1956) and by Harper (1977).

The present study showed that the genotypes grown in binary mixtures with a range of associated genotypes at the 3 cm spacing, showed significant deviations from normality for all characters, except the number of kernels per head and height of the flag leaf (Appendix 8). At the 9 cm spacing, deviations from normality occurred for the number of tillers, the number of heads, kernels per plant, 1000 kernel weight and harvest index.

Deviations from normality will affect the accuracy with which genotypes can be distinguished, and will lead to gains from selection which are different than those expected based on the above formula.

The effect which a positively skewed distribution would have on single plant selection is graphically illustrated in Figure 4a. If genotypes with a high value of a certain character are to be selected, a positive skewness would increase the probability for less desirable genotypes to be present in the selected fraction. Similarly, a negative skewness (or selection of plants with the lowest values for a certain character from a population with a positively skewed distribution) would result in a selected fraction with more desirable genotypes than would have been the case if the character had been normally distributed.

To quantify this effect, the distribution of chi-square, which is a typical skewed distribution, can be conveniently used (Appendix 20). It has been shown, that the effect of skewness on single plant selection became much larger when the frequency of superior genotypes in the population was low. (Dr. D. H. Kelker, Associate Professor of Statistics, University of Alberta, Edmonton, Alberta, 1981, Personal communication). A positive skewness would, thus, result in gains from selection which are much lower than expected, based on estimates of heritability. Similarly, a negative skewness would result in a higher than expected gain from selection, if the highest values from the population were selected.

Considering these facts, Appendix 8 leads to the conclusion that response to selection at the 3 cm spacing would be less than expected for the number of tillers, the

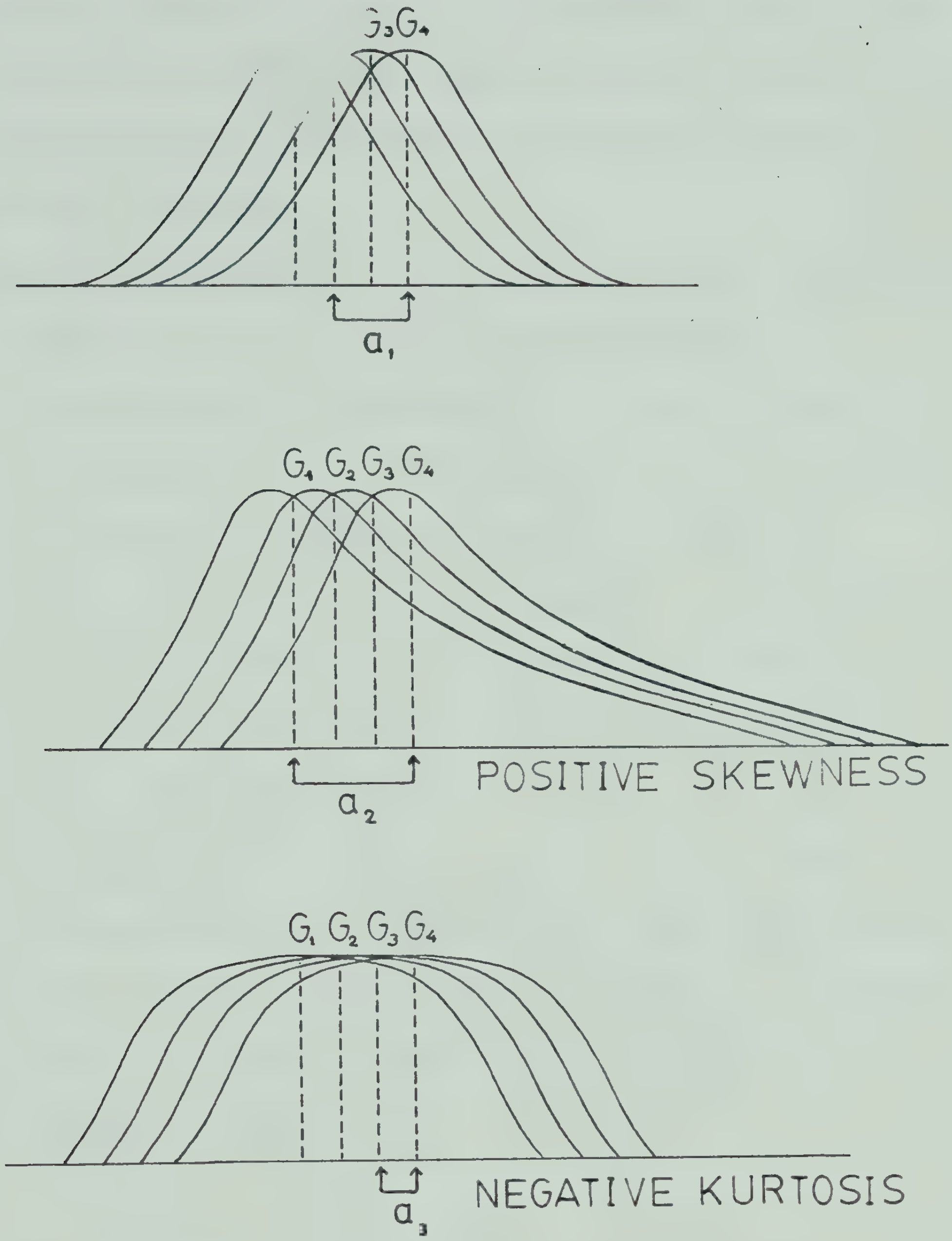

Fig. 4. The effect of skewness and kurtosis of the distribution of a plant character on single plant selection. G_1 - G_4 represent genotypes in a mixture, with means at equal distances apart. a_1, a_2 and a_3 are the ranges of genotypes selected in populations with a normal distribution, a positive skewness, and a positive kurtosis, respectively. $a_3 < a_1 < a_2$.

number of heads, weight, yield and kernels per plant, and greater than expected for 1000 kernel weight, harvest index, height and extrusion length, provided that the tallest individuals were selected.

As was mentioned earlier, little can be said about the effect of a significant kurtosis in the presence of skewness. In the absence of skewness, however, a positive kurtosis is likely to have an adverse effect on selection (Figure 4b), because the selected fraction would be contaminated with less desirable genotypes to a greater extent than would be the case if the character had been normally distributed. Similarly, better results can be expected with a negative kurtosis.

At the 9 cm spacing, selection for a large number of tillers or a large number of kernels per head could result in smaller than expected gains, while selection of plants with a high harvest index or large kernels could result in a higher than expected gain.

9.2 Effects of genotype interaction on single plant selection

The results from the experiment conducted in 1978 suggest that within-genotype variation of several characters would be significantly increased by genotype interaction if the plants were grown in a multi-component mixture. At the the 3 cm spacing, the number of tillers, weight and yield

were affected by genotype interaction, while at the 9 cm spacing, 1000 kernel weight showed an increase in variation (Table 4).

The effect of genotype interaction on estimates of heritability is shown in Tables 21a and 21b for the data from the experiment grown in 1978. Analyses of variance for each interplant spacing, using a random model (Steel and Torrie, 1980), provided the variance components which were used to estimate the values of H^2 (Briggs et al, 1978). Differences between the two estimates suggest that genotype interaction can lead to higher estimates of heritability, in particular for the characters weight, yield and kernels per plant. This observation supports the idea that H^2 is not allways a reliable predictor for the ease with which a character can be inproved through selection.

9.3 Effects of interplant spacing on single plant selection

The within-genotype variation for several characters of plants grown in monoculture increased significantly with an increase in spacing (Table 4). The mean variation of the four genotypes, when grown in mixture, increased significantly with the increase in spacing for all characters, except kernels per head and components of height.

This suggests that identification of superior genotypes would be more successful at the 3 cm than at the 9 cm

Table 21a. Estimates of heritability of single plant characters, grown at a 3 cm interplant spacing, as computed from monoculture and mixture data of four genotypes.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character[2]	Heritability	
	Computed from monoculture data	Computed from mixture data
T	0.57	0.57
H	0.66	0.70
Wt	0.16	0.50
Y	0.35	0.63
K/P	0.04	0.35
Kwt	0.91	0.94
K/H	0.70	0.83
HI	0.63	0.63
FL	0.88	0.89
Ht	0.83	0.83
ExL	0.01	0.48
HL	0.87	0.90

1. $\text{Heritability} = \dfrac{\text{Genetic variation}}{\text{Total variation}}$

2. Character abbreviations defined in Table 1. HL = Head length.

Table 21b. Estimates of heritability of single plant characters, grown at a 9 cm interplant spacing as computed from monoculture and mixture data of four genotypes.

All plants were grown in four row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character[2]	Heritability	
	Computed from monoculture data	Computed from mixture data
T	0.0	0.0
H	0.0	0.32
Wt	0.48	0.67
Y	0.50	0.71
K/P	0.19	0.45
Kwt	0.97	0.97
K/H	0.71	0.77
HI	0.71	0.71
FL	0.91	0.91
Ht	0.74	0.74
ExL	0.78	0.87
HL	0.87	0.94

1. $\text{Heritability} = \dfrac{\text{Genetic variation}}{\text{Total variation}}$

2. Character abbreviations defined in Table 1. HL = Head length.

spacing, because the genetic variance at the 3 cm spacing and at the the 9 cm spacing is approximately the same, differing only by an amount representing genotype x spacing interaction.

Other studies led to different conclusions, however. In an earlier study concerning the same genotypes as were used in the present experiment, a decrease rather than an increase in variation with an increase in spacing was observed for most characters (Kelker and Briggs, 1978). The different results may be partially explained by the fact that in the present study, the difference between the two seeding rates was much larger than in the earlier study. In addition, the distance between rows was larger in the present experiment than in the previous study, resulting in a different spatial arrangement of the plants, which would cause different neighbour interactions (Harper, 1961; Donald, 1963). It is unlikely, though, that these factors can account for a complete reversal of the effect of an increase in spacing on plant-to-plant variation.

Nass (1980) observed that, while biological yield and grain yield of plants from two spring wheat crosses responded each in a different manner to a ten-fold increase in plant spacing, harvest index of plants from both crosses was less variable at a higher (commercial) plant density. Nass recommended growing plants at commercial crop densities, if plants with high harvest index were to be selected. The commercial seeding rate for the humid Prince

Edward Island environment, however, is more than double the rate used in Alberta.

The fact that different seeding rates as well as different planting patterns were used in the various studies, makes it difficult to compare their results. It can be concluded, though, that an increase in plant spacing does not always result in an increase in plant-to-plant variation. The contrasting results from the two Alberta studies, concerning the same genotypes, suggest that location effects and year effects may play an important role.

The present study showed that mean values of most characters were significantly affected by spacing effects as well as by genotype x spacing interaction effects (Table 5). This could lead to different results from selection at different spacings (CIMMYT, 1972; Nass, 1980). For this reason, as well as to avoid a possible increase in variation, selection should be practiced at a density which approximates the commercial seeding rate of the region to which the selected genotypes have to be adapted.

9.4 Effects of seed size on single plant selection

The experiments performed to evaluate the effect of variation in initial seed size on plant-to-plant variation, suggested that variation in seed size can be an additional source of error in the identification of superior genotypes.

The number of heads, the number of tillers and 1000 kernel weight appeared to vary with initial seed size, while harvest index and 1000 kernel weight were affected by variations in seed size among neighbouring plants. Thus, the use of uniform seed would reduce the plant-to-plant variation observed in the selection plots.

This has earlier been suggested by Christian and Gray (1941) and by Chebib et al. (1973). However, the sorting of seed should aim for seed of medium size, to avoid selection for large kernelweight. The latter could be an undesirable side effect, because the number of kernels per head and 1000 kernel weight are negatively correlated (Fischer, 1975 ;Jenner, 1979). Reports of studies investigating the effects of selection for increased kernel size on yield are contradictory (Bhatt and Derera, 1973; Rasmusson and Cannell, 1970), while the percent protein in the kernels tends to decline with an increase in kernel size (Röbbelen, 1979). The merits of seeding uniform seed would, therefore, have to be evaluated for each selection program in light of its breeding objectives.

9.5 Suitability of various characters for single plant selection

The formula for the calculation of heritability shows that the highest values will be obtained for characters which:

a show a large amount of additive genetic variation, and
b are little affected by random environmental variation.

The previous sections of this chapter explained that, in addition, the best chances for genetic improvement through selection exist for those characters which, in a segregating population grown at a commercial crop density:

c are little affected by variations in initial seed size,
d are little affected by neighbour interactions arising from variations in seed size,
e are little affected by genotype interactions, and
f have a distribution which is negatively skewed (if the lowest values are to be selected the skewness should be positive).

For most characters, there are one or more factors by which selection is hindered. Estimates of heritability would encompass the factors mentioned in the points a, b, c and d. To what extent H^2 is biased through genotype interaction effects would depend on the method of calculation (Hamblin and Rosielle, 1978). The effects of non-normality are not accounted for.

Because only homozygous genotypes were used in this study, there is only additive genetic variation, and a hypothetical mixture of these genotypes would be unrepresentative of a segregating population. But the characters measured in this study can be evaluated with respect to the remaining points which determine the efficiency of selection. It then appears that the characters

1000 kernel weight and harvest index did fullfill these requirements best (Tables 4, 5, 12d), and gains from selection could be higher than suggested by an estimate of heritability. Based on the data from this study, the number of tillers, the number of heads and yield can be expected to respond poorly to single plant selection, resulting in less genetic improvement than expected. Of the remaining characters, none had a distribution which would interfere with predictions of gain from selection. Genotype interaction, however, biased estimates of heritability for plant weight, yield and kernels per plant.

It was explained that kernel weight is not always a reliable indicator of yield and may affect percent protein of the selected genotypes. Selection for high harvest index, as an indirect method for selection for yield, however, has shown promising results (Donald and Hamblin, 1976; Fischer and Kertesz, 1976; Bhatt, 1977). The present study gives support to the observation that selection for high harvest index can result in high gains from selection (Bhatt, 1977).

The results from the present study suggest, that, in order to evaluate the suitability of a character for selection in early generations, the distribution of this character in a multi-component mixture, as well as its sensitivity to genotype interaction, should be evaluated at a commercial plant density, in conjunction with the estimation of its heritability. The combined information

could then lead to a more realistic expectation of the progress which can be made through selection.

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11. List of Appendices

Appendix 1. Mean monthly temperatures and precipitation near the test sites, for the growing seasons of 1977, 1978 and 1979, and the long term averages.

A. Edmonton

Month	Temperature (°C)			Rainfall (mm)		
	1977	1979	Long term average [1]	1977	1979	Long term average
May	11.8	8.7	10.9	134	38	37
June	15.6	14.9	14.7	11	63	75
July	15.6	17.8	17.5	107	122	83
August	13.4	16.5	15.9	91	39	72
September	9.6	12.9	10.9	40	22	36

B. Ellerslie

Month	Temperature (C)		Rainfall (mm)	
	1978	Long term average [2]	1978	Long term average
May	10.5	10.5	59	47
June	16.0	14.0	38	84
July	16.5	16.0	114	85
August	14.5	15.0	94	68
September	12.0	10.0	34	36

1 Average of 99 years. Information obtained from the Annual Meteorological Summary for the Edmonton Municipal Airport, issued by Environment Canada, 1980.

2 Average of 17 years. Information obtained from the Department of Geography, Division of Meteorology, 1980.

Appendix 2. Details regarding fertiliser and herbicide application to the 1977, 1978 and 1979 locations.

Location	Fertiliser[1] (kg/ha)			Herbicide		
	N	P	K	Trade name[2]	Growth stage	Rate of application
Edmonton 1977	14	34	0	Buctril M	3-5 leaf	237 m/ha
Ellerslie 1978	14	34	0	Avadex	N. A.[3]	13.6 kg/ha
				MCPA-K	3-5 leaf	237 ml/ha
				Banvel	3-5 leaf	44 ml/ha
Edmonton 1979	5.5	14	0	Avadex	N.A.	14.2 kg/ha

1. Actual amounts N, P and K applied, derived from granular mono ammonium phosphate ($NH_4K_2PO_4$) in a broadcast application; applied two weeks before seeding and incorporated by disking.

2. Active ingredients:

   Buctril M: 3,5-dibromo-4-hydroxybenzonitrile
   Avadex: S-(2,3,3-trichloroallyl) diisopropyl thiocarbamate
   MCPA-K: K-salt of 2-Methyl, 4-chlorophenoxyacetic acid
   Banvel: 2 methoxy-3,6-dichlorobenzoicacid

3. N. A. = not applicable.

Appendix 3. Agronomic characters of wheat genotypes in the study.

Genotype	Maturity[1]	Height (cm)[2]	Tiller number per plant[3]	1000 kernel weight (g)[4]
Pitic 62	+6	85	4.5	36.7
Glenlea	+8	108	2.6	44.6
Park	-1	101	4.5	33.4
Neepawa	0	102	No data	32.9
[illegible]0001[5]	+3	91	No data	44.2
70M009002[6]	+4	86	3.3	42.8
Norquay	+4	82	3.4	36.6
NB 701[7]	+1	108	No data	43.0

1. Number of days earlier or later than Neepawa (Attinaw, 1977).

2. Attinaw, 1977

3. Average of 1978, 1979 tests, plants 3 cm apart in rows 30 cm apart

4. Average of 1977, 1978, 1979 seedlots used.

5. Pedigree of 70M110001 = CIANO S × ((CIANO × SON-KL REND)8156)

6. Pedigree of 70M00900 = CIANO S × ((SON 64-Y 50ES × G10)INIA'S')

7. Data obtained from 1976 Co-op NonBread Wheat Test, Edmonton.

   Pedigree of NB701 = ((SON 64-Y 50ES × G10)INIA) × INIA'S' - NAPO

Appendix 4. Thousand kernel weight (1000 kwt) and percent germination (% germ) of the seed used for the experiments in 1977, 1978 and 1979.

Genotype	1977		1978		1979	
	1000 kwt	% germ	1000 kwt	% germ	1000 kwt	% germ
Pitic 62	34.3	84.0	39.1	99.5	No data	98.5
Glenlea	42.5	95.0	4[illegible].8	93.5	44.5	97.5
Park	33.5	96.0	31.8	99.0	34.9	98.5
Neepawa	32.1	99.0	33.2	99.0	33.5	82.5
70M110001	35.9	98.0	47.9	94.5	48.9	99.0
70M009002	33.6	92.0	48.9	100.0	45.9	99.5
Norquay	35.8	88.5	36.6	98.5	37.3	87.0
NB 701	38.9	98.0	43.1	85.0	47.1	91.0

Appendix 5. Number of plants available per treatment, from each density, for analysis of the wheelplot experiment, grown in 1977.

Genotype	Associate Genotype	Plants per treatment						
		204[1]	124	69	44	28	17	10
Glenlea	Glenlea	11	14	13	13	15	13	8
	Neepawa	7	7	7	6	5	7	5
	70M110001	6	7	8	5	-[2]	-	6
	70M009002	9	-	10	5	5	-	-
	NB 701	-	7	7	5	-	-	-
Park	Park	6	14	12	11	15	13	13
	Neepawa	-	5	6	-	-	-	-
	70M110001	7	8	-	-	-	-	-
	70M009002	6	7	7	8	7	6	7
	NB 701	6	7	7	9	7	7	6
Neepawa	Glenlea	7	10	7	8	6	7	6
	Park	-	7	7	-	-	-	-
	70M110001	6	-	-	-	-	-	-
	Norquay	-	-	-	-	6	7	-
	NB 701	7	6	6	9	7	6	6
70M110001	70M110001	16	10	10	11	12	8	9
	Glenlea	6	6	6	7	-	-	5
	Park	8	6	-	-	-	-	-
	Neepawa	5	-	-	-	-	-	-
	NB 701	-	-	7	9	-	-	5
70M009002	Glenlea	5	7	6	5	5	6	5
	Park	7	6	6	-	6	8	7
	NB 701	6	9	6	7	7	8	9
Norquay	Norquay	-	6	6	7	-	-	6
	Neepawa	-	-	-	-	8	7	6
	NB 701	9	6	-	-	-	-	8
NB 701	Glenlea	-	6	6	5	-	-	-
	Park	8	6	-	5	6	7	9
	Neepawa	7	7	7	7	7	7	8
	70M110001	-	-	5	6	-	-	5
	70M009002	5	5	6	8	5	5	7
	Norquay	5	8	-	-	-	5	-

1. Plant density (plants/m^2)

2. Less than five plants available

Appendix 6. Descriptive statistics of characters of plants, grown in monoculture and in mixture at various interplant spacings, measured at maturity in 1977.

FILE WP77 (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE HT PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			98417.0000	93.8198	15.8889	252.4570	(1049)
CUL	2.	GLENLEA	20281.0000	111.4341	8.8044	77.5177	(182)
SPAC	1	204 PLANTS M	2695.0000	112.2917	11.0748	122.6504	(24)
COMP	1	MONOCULTURE	1250.0000	113.6364	8.1520	66.4545	(11)
COMP	2	MIXTURE	1445.0000	111.1538	13.2906	176.6410	(13)
SPAC	2	3 CM SPACING	3982.0000	113.7714	9.9826	99.6521	(35)
COMP	1	MONOCULTURE	1556.0000	111.1429	15.0018	225.0549	(14)
COMP	2	MIXTURE	2426.0000	115.5238	3.8810	15.0619	(21)
SPAC	3	9 CM SPACING	3897.0000	111.3429	9.2417	85.4084	(35)
COMP	1	MONOCULTURE	1474.0000	113.3846	3.4288	11.7564	(13)
COMP	2.	MIXTURE	2423.0000	110.1364	11.2897	127.4567	(22)
SPAC	4.	44 PLANTS M	3232.0000	111.4483	8.7447	76.4704	(29)
COMP	1	MONOCULTURE	1482.0000	114.0000	2.5820	6.6667	(13)
COMP	2	MIXTURE	1750.0000	109.3750	11.2776	127.1833	(16)
SPAC	5	28 PLANTS M	2223.0000	111.1500	4.2212	17.8184	(20)
COMP	1	MONOCULTURE	1663.0000	110.8667	3.7007	13.6952	(15)
COMP	2.	MIXTURE	560.0000	112.0000	5.9582	35.5000	(5)
SPAC	6	17 PLANTS M	2202.0000	110.1000	5.6930	32.4105	(20)
COMP	1	MONOCULTURE	1440.0000	110.7692	5.5995	31.3590	(13)
COMP	2	MIXTURE	762.0000	108.8571	6.0945	37.1429	(7)
SPAC	7	10 PLANTS M	2050.0000	107.8947	8.6210	74.3216	(19)
COMP	1	MONOCULTURE	874.0000	109.2500	5.3385	28.5000	(8)

CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	1176.0000	106.9091	10.5495	111.2909	(11)
CUL	3.	PARK	19816.0000	95.7295	7.3521	54.0527	(207)
SPAC	1.	204 PLANTS M	2443.0000	97.7200	7.0977	50.3767	(25)
COMP	1.	MONOCULTURE	607.0000	101.1667	5.7417	32.9667	(6)
COMP	2.	MIXTURE	1836.0000	96.6316	7.2664	52.8012	(19)
SPAC	2.	3 CM SPACING	3954.0000	96.4390	9.0223	81.4024	(41)
COMP	1.	MONOCULTURE	1393.0000	99.5000	10.6464	113.3462	(14)
COMP	2.	MIXTURE	2561.0000	94.8519	7.8039	60.9003	(27)
SPAC	3.	9 CM SPACING	3168.0000	99.0000	5.0737	25.7419	(32)
COMP	1.	MONOCULTURE	1230.0000	102.5000	4.2959	18.4545	(12)
COMP	2.	MIXTURE	1938.0000	96.9000	4.3516	18.9368	(20)
SPAC	4.	44 PLANTS M	2686.0000	95.9286	8.2324	67.7725	(28)
COMP	1.	MONOCULTURE	1093.0000	99.3636	4.0810	16.6545	(11)
COMP	2.	MIXTURE	1593.0000	93.7059	9.5182	90.5956	(17)
SPAC	5.	28 PLANTS M	2815.0000	97.0690	3.7410	13.9951	(29)
COMP	1.	MONOCULTURE	1459.0000	97.2667	3.1275	9.7810	(15)
COMP	2.	MIXTURE	1356.0000	96.8571	4.4177	19.5165	(14)
SPAC	6.	17 PLANTS M	2396.0000	92.1538	6.8217	46.5354	(26)
COMP	1.	MONOCULTURE	1192.0000	91.6923	7.6418	58.3974	(13)
COMP	2.	MIXTURE	1204.0000	92.6154	6.1717	38.0897	(13)
SPAC	7.	10 PLANTS M	2354.0000	90.5385	6.1269	37.5385	(26)
COMP	1.	MONOCULTURE	1185.0000	91.1538	6.1080	37.3077	(13)
COMP	2.	MIXTURE	1169.0000	89.9231	6.3306	40.0769	(13)
CUL	4.	70M009002	12498.0000	95.4046	8.8524	78.3658	(131)
SPAC	1.	204 PLANTS M	1908.0000	95.4000	9.3268	86.9895	(20)
COMP	2.	MIXTURE	1908.0000	95.4000	9.3268	86.9895	(20)
SPAC	2.	3 CM SPACING	2305.0000	100.2174	10.2645	105.3597	(23)
COMP	2.	MIXTURE	2305.0000	100.2174	10.2645	105.3597	(23)

CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	1938.0000	96.9000	8.0518	64.8316	(20)
COMP	2.	MIXTURE	1938.0000	96.9000	8.0518	64.8316	(20)
SPAC	4.	44 PLANTS M	1618.0000	95.1765	10.9672	120.2794	(17)
COMP	2.	MIXTURE	1618.0000	95.1765	10.9672	120.2794	(17)
SPAC	5.	28 PLANTS M	1829.0000	96.2632	4.8286	23.3158	(19)
COMP	2	MIXTURE	1829.0000	96.2632	4.8286	23.3158	(19)
SPAC	6	17 PLANTS M	1836.0000	91.8000	6.2627	39.2211	(20)
COMP	2.	MIXTURE	1836.0000	91.8000	6.2627	39.2211	(20)
SPAC	7	10 PLANTS M	1064.0000	88.6667	6.7330	45.3333	(12)
COMP	2.	MIXTURE	1064.0000	88.6667	6.7330	45.3333	(12)
CUL	5.	NORQUAY	10969.0000	75.1301	10.8572	117.8795	(146)
SPAC	1.	204 PLANTS M	2639.0000	75.4000	10.8579	117.8941	(35)
COMP	1.	MONOCULTURE	1213.0000	75.8125	5.7760	33.3625	(16)
COMP	2.	MIXTURE	1426.0000	75.0526	13.9502	194.6082	(19)
SPAC	2.	3 CM SPACING	1679.0000	76.3182	15.0187	225.5606	(22)
COMP	1.	MONOCULTURE	796.0000	79.6000	9.3595	87.6000	(10)
COMP	2	MIXTURE	883.0000	73.5833	18.4660	340.9924	(12)
SPAC	3.	9 CM SPACING	1750.0000	76.0870	12.3616	152.8103	(23)
COMP	1	MONOCULTURE	709.0000	70.9000	7.4304	55.2111	(10)
COMP	2.	MIXTURE	1041.0000	80.0769	14.1095	199.0769	(13)
SPAC	4.	44 PLANTS M	2069.0000	76.6296	10.5617	111.5499	(27)
COMP	1.	MONOCULTURE	811.0000	73.7273	5.7461	33.0182	(11)
COMP	2.	MIXTURE	1258.0000	78.6250	12.6853	160.9167	(16)
SPAC	5	28 PLANTS M	844.0000	70.3333	4.2923	18.4242	(12)
COMP	1	MONOCULTURE	844.0000	70.3333	4.2923	18.4242	(12)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	565.0000	70.6250	4.2405	17.9821	(8)
COMP	1.	MONOCULTURE	565.0000	70.6250	4.2405	17.9821	(8)
SPAC	7.	10 PLANTS M	1423.0000	74.8947	8.1711	66.7661	(19)
COMP	1.	MONOCULTURE	660.0000	73.3333	2.5000	6.2500	(9)
COMP	2.	MIXTURE	763.0000	76.3000	11.1061	123.3444	(10)
CUL	6.	70M009002	10194.0000	77.8168	8.2935	68.7816	(131)
SPAC	1.	204 PLANTS M	1486.0000	82.5556	11.0997	123.2026	(18)
COMP	2.	MIXTURE	1486.0000	82.5556	11.0997	123.2026	(18)
SPAC	2.	3 CM SPACING	1728.0000	78.5455	7.0287	49.4026	(22)
COMP	2.	MIXTURE	1728.0000	78.5455	7.0287	49.4026	(22)
SPAC	3.	9 CM SPACING	1447.0000	80.3889	7.2772	52.9575	(18)
COMP	2.	MIXTURE	1447.0000	80.3889	7.2772	52.9575	(18)
SPAC	4.	44 PLANTS M	989.0000	82.4167	8.8159	77.7197	(12)
COMP	2.	MIXTURE	989.0000	82.4167	8.8159	77.7197	(12)
SPAC	5.	28 PLANTS M	1314.0000	73.0000	5.4772	30.0000	(18)
COMP	2.	MIXTURE	1314.0000	73.0000	5.4772	30.0000	(18)
SPAC	6.	17 PLANTS M	1660.0000	75.4545	6.7944	46.1645	(22)
COMP	2.	MIXTURE	1660.0000	75.4545	6.7944	46.1645	(22)
SPAC	7.	10 PLANTS M	1570.0000	74.7619	7.2450	52.4905	(21)
COMP	2.	MIXTURE	1570.0000	74.7619	7.2450	52.4905	(21)
CUL	7.	NORQUAY	5371.0000	77.8406	6.4160	41.1654	(69)
SPAC	1.	204 PLANTS M	733.0000	81.4444	2.7889	7.7778	(9)
COMP	2.	MIXTURE	733.0000	81.4444	2.7889	7.7778	(9)
SPAC	2.	3 CM SPACING	953.0000	79.4167	3.3428	11.1742	(12)
COMP	1.	MONOCULTURE	473.0000	78.8333	3.2506	10.5667	(6)

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CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	480.0000	80.0000	3.6332	13.2000	(6)
SPAC	3.	9 CM SPACING	440.0000	73.3333	5.2409	27.4667	(6)
COMP	1.	MONOCULTURE	440.0000	73.3333	5.2409	27.4667	(6)
SPAC	4.	44 PLANTS M	551.0000	78.7143	7.1581	51.2381	(7)
COMP	1.	MONOCULTURE	551.0000	78.7143	7.1581	51.2381	(7)
SPAC	5.	28 PLANTS M	666.0000	83.2500	7.9776	63.6429	(8)
COMP	2.	MIXTURE	666.0000	83.2500	7.9776	63.6429	(8)
SPAC	6.	17 PLANTS M	1141.0000	76.0667	5.2436	27.4952	(15)
COMP	2.	MIXTURE	1141 0000	76.0667	5 2436	27.4952	(15)
SPAC	7	10 PLANTS M	887 0000	73.9167	7.3788	54.4470	(12)
COMP	1.	MONOCULTURE	449 0000	74.8333	3.6560	13.3667	(6)
COMP	2.	MIXTURE	438.0000	73.0000	10.2176	104.4000	(6)
CUL	8.	NB701	19288.0000	105.3989	9.4159	88 6587	(183)
SPAC	1	204 PLANTS M	2762.0000	110.4800	7.4728	55.8433	(25)
COMP	2.	MIXTURE	2762.0000	110.4800	7.4728	55.8433	(25)
SPAC	2.	3 CM SPACING	3530.0000	110.3125	9.5830	91.8347	(32)
COMP	2.	MIXTURE	3530.0000	110.3125	9.5830	91.8347	(32)
SPAC	3.	9 CM SPACING	2622.0000	109.2500	6.2780	39 4130	(24)
COMP	2.	MIXTURE	2622.0000	109.2500	6.2780	39 4130	(24)
SPAC	4.	44 PLANTS M	3286.0000	106.0000	7.7589	60.2000	(31)
COMP	2	MIXTURE	3286.0000	106.0000	7.7589	60.2000	(31)
SPAC	5.	28 PLANTS M	1896.0000	105.3333	6.9452	48 2353	(18)
COMP	2.	MIXTURE	1896.0000	105.3333	6.9452	48.2353	(18)
SPAC	[illegible]	17 PLANTS M	2381.0000	99.2083	10.6648	113.7373	(24)
COMP	2.	MIXTURE	2381.0000	99.2083	10.6648	113.7373	(24)

CRITERION VARIABLE HT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	2811.0000	96.9310	6.0234	36.2808	(29)
COMP	2.	MIXTURE	2811.0000	96.9310	6.0234	36.2808	(29)

TOTAL CASES = 1080
MISSING CASES = 31 OR 2.9 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -
CRITERION VARIABLE FL HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			37001.0000	35.3063	7.8172	61.1086	(1048)
CUL	2	GLENLEA	7161.0000	39.3462	6.4161	41.1668	(182)
SPAC	1.	204 PLANTS M	933.0000	38.8750	4.0358	16.2880	(24)
COMP	1.	MONOCULTURE	433.0000	39.3636	3.7755	14.2545	(11)
COMP	2.	MIXTURE	500.0000	38.4615	4.3515	18.9359	(13)
SPAC	2.	3 CM SPACING	1400.0000	40.0000	4.4721	20.0000	(35)
COMP	1.	MONOCULTURE	540.0000	38.5714	5.0340	25.3407	(14)
COMP	2.	MIXTURE	860.0000	40.9524	3.8920	15.1476	(21)
SPAC	3.	9 CM SPACING	1363.0000	38.9429	9.0844	82.5261	(35)
COMP	1.	MONOCULTURE	531.0000	40.8462	13.9454	194.4744	(13)
COMP	2.	MIXTURE	832.0000	37.8182	4.3495	18.9177	(22)
SPAC	4.	44 PLANTS M	1148.0000	39.5862	7.1640	51.3227	(29)
COMP	1.	MONOCULTURE	515.0000	39.6154	9.3856	88.0897	(13)
COMP	2.	MIXTURE	633.0000	39.5625	5.0328	25.3292	(16)
SPAC	5.	28 PLANTS M	807.0000	40.3500	7.9490	63.1868	(20)
COMP	1.	MONOCULTURE	597.0000	39.8000	8.6206	74.3143	(15)
COMP	2.	MIXTURE	210.0000	42.0000	5.9582	35.5000	(5)
SPAC	6.	17 PLANTS M	778.0000	38.9000	5.2405	27.4632	(20)
COMP	1.	MONOCULTURE	501.0000	38.5385	5.3481	28.6026	(13)
COMP	2.	MIXTURE	277.0000	39.5714	5.3807	28.9524	(7)
SPAC	7.	10 PLANTS M	732.0000	38.5263	4.5138	20.3743	(19)
COMP	1.	MONOCULTURE	307.0000	38.3750	5.2627	27.6964	(8)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	425.0000	38.6364	4.1539	17.2545	(11)
CUL	3.	PARK	8509.0000	41.1063	5.2035	27.0760	(207)
SPAC	1.	204 PLANTS M	999.0000	39.9600	6.3343	40.1233	(25)
COMP	1.	MONOCULTURE	256.0000	42.6667	3.5024	12.2667	(6)
COMP	2.	MIXTURE	743.0000	39.1053	6.8467	46.8772	(19)
SPAC	2.	3 CM SPACING	1697.0000	41.3902	5.2148	27.1939	(41)
COMP	1.	MONOCULTURE	604.0000	43.1429	4.9592	24.5934	(14)
COMP	2.	MIXTURE	1093.0000	40.4815	5.1989	27.0285	(27)
SPAC	3.	9 CM SPACING	1316.0000	41.1250	5.4875	30.1129	(32)
COMP	1.	MONOCULTURE	520.0000	43.3333	2.2697	5.1515	(12)
COMP	2.	MIXTURE	796.0000	39.8000	6.4204	41.2211	(20)
SPAC	4.	44 PLANTS M	1177.0000	42.0357	6.1793	38.1839	(28)
COMP	1.	MONOCULTURE	488.0000	44.3636	3.8800	15.0545	(11)
COMP	2.	MIXTURE	689.0000	40.5294	6.9921	48.8897	(17)
SPAC	5.	28 PLANTS M	1261.0000	43.4828	3.9245	15.4015	(29)
COMP	1.	MONOCULTURE	650.0000	43.3333	3.8666	14.9524	(15)
COMP	2.	MIXTURE	611.0000	43.6429	4.1251	17.0165	(14)
SPAC	6.	17 PLANTS M	1051.0000	40.4231	3.9311	15.4538	(26)
COMP	1.	MONOCULTURE	532.0000	40.9231	4.2517	18.0769	(13)
COMP	2.	MIXTURE	519.0000	39.9231	3.6847	13.5769	(13)
SPAC	7.	10 PLANTS M	1008.0000	38.7692	3.8294	14.6646	(26)
COMP	1.	MONOCULTURE	512.0000	39.3846	4.7878	22.9231	(13)
COMP	2.	MIXTURE	496.0000	38.1538	2.6092	6.8077	(13)
CUL	4.	70M008002	4471.0000	34.1298	5.6465	31.8830	(131)
SPAC	1.	204 PLANTS M	695.0000	34.7500	8.0320	64.5132	(20)
COMP	2.	MIXTURE	695.0000	34.7500	8.0320	64.5132	(20)
SPAC	2.	3 CM SPACING	782.0000	34.0000	4.7863	22.9091	(23)
COMP	2.	MIXTURE	782.0000	34.0000	4.7863	22.9091	(23)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	710.0000	35.5000	6.3619	40.4737	(20)
COMP	2.	MIXTURE	710.0000	35.5000	6.3619	40.4737	(20)
SPAC	4.	44 PLANTS M	555.0000	32.6471	6.8733	47.2426	(17)
COMP	2.	MIXTURE	555.0000	32.6471	6.8733	47.2426	(17)
SPAC	5	28 PLANTS M	643.0000	33.8421	4.4003	19.3626	(19)
COMP	2.	MIXTURE	643.0000	33.8421	4.4003	19.3626	(19)
SPAC	6.	17 PLANTS M	665.0000	33.2500	3.6689	13.4605	(20)
COMP	2.	MIXTURE	665.0000	33.2500	3.6689	13.4605	(20)
SPAC	7.	10 PLANTS M	421.0000	35.0833	3.9877	15.9015	(12)
COMP	2.	MIXTURE	421.0000	35.0833	3.9877	15.9015	(12)
CUL	5.	NORDUAY	4486.0000	30.9379	5.2005	27.0447	(145)
SPAC	1.	204 PLANTS M	1085.0000	31.0000	4.3250	18.7059	(35)
COMP	1.	MONOCULTURE	509.0000	31.8125	3.2087	10.2958	(16)
COMP	2.	MIXTURE	576.0000	30.3158	5.0668	25.6725	(19)
SPAC	2.	3 CM SPACING	648.0000	29.4545	6.6814	44.6407	(22)
COMP	1.	MONOCULTURE	308.0000	30.8000	3.8239	14.6222	(10)
COMP	2.	MIXTURE	340.0000	28.3333	8.3811	70.2424	(12)
SPAC	3.	9 CM SPACING	728.0000	31.6522	4.0967	16.7826	(23)
COMP	1.	MONOCULTURE	314.0000	31.4000	4.3256	18.7111	(10)
COMP	2.	MIXTURE	414.0000	31.8462	4.0793	16.6410	(13)
SPAC	4.	44 PLANTS M	806.0000	31.0000	7.0937	50.3200	(26)
COMP	1.	MONOCULTURE	317.0000	31.7000	3.5292	12.4556	(10)
COMP	2.	MIXTURE	489.0000	30.5625	8.7099	75.8625	(16)
SPAC	5.	28 PLANTS M	358.0000	29.8333	4.6482	21.6061	(12)
COMP	1.	MONOCULTURE	358.0000	29.8333	4.6482	21.6061	(12)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	259.0000	32.3750	4.4701	19.9821	(8)
COMP	1.	MONOCULTURE	259.0000	32.3750	4.4701	19.9821	(8)
SPAC	7.	10 PLANTS M	602.0000	31.6842	3.4489	11.8947	(19)
COMP	1.	MONOCULTURE	285.0000	31.6667	1.8028	3.2500	(9)
COMP	2.	MIXTURE	317.0000	31.7000	4.5717	20.9000	(10)
CUL	6.	70M009002	3409.0000	26.0229	5.3125	28.2225	(131)
SPAC	1.	204 PLANTS M	511.0000	28.3889	5.1465	26.4869	(18)
COMP	2.	MIXTURE	511.0000	28.3889	5.1465	26.4869	(18)
SPAC	2.	3 CM SPACING	593.0000	26.9545	4.6953	22.0455	(22)
COMP	2.	MIXTURE	593.0000	26.9545	4.6953	22.0455	(22)
SPAC	3.	9 CM SPACING	488.0000	27.1111	7.9623	63.3987	(18)
COMP	2.	MIXTURE	488.0000	27.1111	7.9623	63.3987	(18)
SPAC	4.	44 PLANTS M	304.0000	25.3333	6.3580	40.4242	(12)
COMP	2.	MIXTURE	304.0000	25.3333	6.3580	40.4242	(12)
SPAC	5.	26 PLANTS M	445.0000	24.7222	3.3921	11.5065	(18)
COMP	2.	MIXTURE	445.0000	24.7222	3.3921	11.5065	(18)
SPAC	6.	17 PLANTS M	566.0000	25.7273	4.0022	16.0173	(22)
COMP	2.	MIXTURE	566.0000	25.7273	4.0022	16.0173	(22)
SPAC	7.	10 PLANTS M	502.0000	23.9048	4.6250	21.3905	(21)
COMP	2.	MIXTURE	502.0000	23.9048	4.6250	21.3905	(21)
CUL	7.	NORQUAY	1953.0000	28.3043	4.5900	21.0678	(69)
SPAC	1.	204 PLANTS M	271.0000	30.1111	6.4507	41.6111	(9)
COMP	2.	MIXTURE	271.0000	30.1111	6.4507	41.6111	(9)
SPAC	2.	3 CM SPACING	341.0000	28.4167	5.1779	26.8106	(12)
COMP	1.	MONOCULTURE	162.0000	27.0000	2.4495	6.0000	(6)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	179.0000	29.8333	6.9402	48.1667	(6)
SPAC	3	9 CM SPACING	152.0000	25.3333	3.8297	14.6667	(6)
COMP	1.	MONOCULTURE	152.0000	25.3333	3.8297	14.6667	(6)
SPAC	4	44 PLANTS M	192.0000	27.4286	2.1492	4.6190	(7)
COMP	1	MONOCULTURE	192.0000	27.4286	2.1492	4.6190	(7)
SPAC	5.	28 PLANTS M	255.0000	31.8750	4.0861	16.6964	(8)
COMP	2	MIXTURE	255.0000	31.8750	4.0861	16.6964	(8)
SPAC	6	17 PLANTS M	408.0000	27.2000	3.7264	13.8857	(15)
COMP	2	MIXTURE	408.0000	27.2000	3.7264	13.8857	(15)
SPAC	7	10 PLANTS M	334.0000	27.8333	4.0639	16.5152	(12)
COMP	1	MONOCULTURE	171.0000	28.5000	3.8341	14.7000	(6)
COMP	2	MIXTURE	163.0000	27.1667	4.5350	20.5667	(6)
CUL	8.	NB701	7012.0000	38.3169	6.8731	47.2397	(183)
SPAC	1.	204 PLANTS M	913.0000	36.5200	5.0754	25.7600	(25)
COMP	2	MIXTURE	913.0000	36.5200	5.0754	25.7600	(25)
SPAC	2.	3 CM SPACING	1207.0000	37.7188	5.0176	25.1764	(32)
COMP	2	MIXTURE	1207.0000	37.7188	5.0176	25.1764	(32)
SPAC	3.	9 CM SPACING	961.0000	40.0417	4.2781	18.3025	(24)
COMP	2.	MIXTURE	961.0000	40.0417	4.2781	18.3025	(24)
SPAC	4.	44 PLANTS M	1222.0000	39.4194	12.1375	147.3183	(31)
COMP	2.	MIXTURE	1222.0000	39.4194	12.1375	147.3183	(31)
SPAC	5.	26 PLANTS M	712.0000	39.5556	5.4796	30.0261	(18)
COMP	2.	MIXTURE	712.0000	39.5556	5.4796	30.0261	(18)
SPAC	6.	17 PLANTS M	900.0000	37.5000	6.8588	47.0435	(24)
COMP	2.	MIXTURE	900.0000	37.5000	6.8588	47.0435	(24)

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CRITERION VARIABLE FL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1097.0000	37.8276	4.2851	18.3621	(29)
COMP	2.	MIXTURE	1097.0000	37.8276	4.2851	18.3621	(29)

TOTAL CASES = 1080
MISSING CASES = 32 OR 3.0 PCT.

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FILE WP77 (CREATION DATE = 03/16/82)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - -

CRITERION VARIABLE H HEADS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			7621.0000	7.2898	5.0084	25.0845	(1044)
CUL	2.	GLENLEA	1600.0000	8 8398	6.7422	45 4575	(181
SPAC	1	204 PLANTS M	94.0000	3 9167	1.7917	3 2101	(24
COMP	1.	MONOCULTURE	44.0000	4.0000	1.7889	3 2000	(11
COMP	2.	MIXTURE	50.0000	3 8462	1.8640	3 4744	(13
SPAC	2	3 CM SPACING	151.0000	4 4412	1.3968	1 9510	(34)
COMP	1.	MONOCULTURE	58.0000	4 4615	1.3914	1.9359	(13
COMP	2.	MIXTURE	93.0000	4 4286	1.4343	2.0571	(21)
SPAC	3.	9 CM SPACING	192.0000	5 4857	1.8210	3.3160	(35)
COMP	1.	MONOCULTURE	68.0000	5 2308	1.5892	2.5256	(13)
COMP	2.	MIXTURE	124.0000	5.6364	1.9651	3.8615	(22)
SPAC	4.	44 PLANTS M	238.0000	8.2069	2.2580	5.0985	(29)
COMP	1.	MONOCULTURE	111.0000	8 5385	1.7614	3.1026	(13)
COMP	2	MIXTURE	127.0000	7.9375	2.6196	6.8625	(16)
SPAC	5.	28 PLANTS M	240.0000	12 0000	5.6008	31.3684	(20)
COMP	1.	MONOCULTURE	158.0000	10 5333	4.3403	18.8381	(15)
COMP	2.	MIXTURE	82.0000	16.4000	7.1274	50.8000	(5)
SPAC	6.	17 PLANTS M	290.0000	14.5000	6.1000	37.2105	(20)
COMP	1.	MONOCULTURE	202.0000	15 5385	5.0599	25.6026	(13)
COMP	2.	MIXTURE	88.0000	12.5714	7.7429	59.9524	(7)
SPAC	7.	10 PLANTS M	395 0000	20 7895	8 4563	71.5088	19)
COMP	1.	MONOCULTURE	161.0000	20 1250	5.1113	26.1250	8)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	234.0000	21.2727	10.4794	109.8182	(11)
CUL	3.	PARK	1337.0000	6.4903	3.3868	11.4706	(206)
SPAC	1.	204 PLANTS M	102.0000	4.0800	1.7059	2.9100	(25)
COMP	1.	MONOCULTURE	24.0000	4.0000	1.8974	3.6000	(6)
COMP	2.	MIXTURE	78.0000	4.1053	1.6962	2.8772	(19)
SPAC	2.	3 CM SPACING	198.0000	4.9500	2.3853	5.6897	(40)
COMP	1.	MONOCULTURE	78.0000	6.0000	1.2247	1.5000	(13)
COMP	2.	MIXTURE	120.0000	4.4444	2.6506	7.0256	(27)
SPAC	3.	9 CM SPACING	179.0000	5.5938	2.1077	4.4425	(32)
COMP	1.	MONOCULTURE	74.0000	6.1667	1.8990	3.6061	(12)
COMP	2.	MIXTURE	105.0000	5.2500	2.1975	4.8289	(20)
SPAC	4.	44 PLANTS M	190.0000	6.7857	2.6854	7.2116	(28)
COMP	1.	MONOCULTURE	75.0000	6.8182	2.9603	8.7636	(11)
COMP	2.	MIXTURE	115.0000	6.7647	2.5867	6.6912	(17)
SPAC	5.	28 PLANTS M	244.0000	8.4138	2.1132	4.4655	(29)
COMP	1.	MONOCULTURE	121.0000	8.0667	2.4631	6.0667	(15)
COMP	2.	MIXTURE	123.0000	8.7857	1.6723	2.7967	(14)
SPAC	6.	17 PLANTS M	223.0000	8.5769	5.1705	26.7338	(26)
COMP	1.	MONOCULTURE	108.0000	8.3077	3.3263	11.0641	(13)
COMP	2.	MIXTURE	115.0000	8.8462	6.6689	44.4744	(13)
SPAC	7.	10 PLANTS M	201.0000	7.7308	4.0255	16.2046	(26)
COMP	1.	MONOCULTURE	83.0000	6.3846	4.1541	17.2564	(13)
COMP	2.	MIXTURE	118.0000	9.0769	3.5464	12.5769	(13)
CUL	4.	70MOO9002	908.0000	6.9313	4.0004	16.0029	(131)
SPAC	1.	204 PLANTS M	85.0000	4.2500	2.1491	4.6184	(20)
COMP	2.	MIXTURE	85.0000	4.2500	2.1491	4.6184	(20)
SPAC	2.	3 CM SPACING	98.0000	4.2609	1.8639	3.4743	(23)
COMP	2.	MIXTURE	98.0000	4.2609	1.8639	3.4743	(23)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	128.0000	6.4000	2.4366	5.9368	(20)
COMP	2	MIXTURE	128.0000	6.4000	2.4366	5.9368	(20)
SPAC	4.	44 PLANTS M	101.0000	5.9412	1.9834	3.9338	(17)
COMP	2	MIXTURE	101.0000	5.9412	1.9834	3.9338	(17)
SPAC	5.	28 PLANTS M	162.0000	8.5263	3.4700	12.0409	(19)
COMP	2	MIXTURE	162.0000	8.5263	3.4700	12.0409	(19)
SPAC	6	17 PLANTS M	185.0000	9.2500	3.5964	12.9342	(20)
COMP	2	MIXTURE	185.0000	9.2500	3.5964	12.9342	(20)
SPAC	7	10 PLANTS M	149.0000	12.4167	6.2589	35.1742	(12)
COMP	2	MIXTURE	145.0000	12.4167	6.2589	39.1742	(12)
CUL	5.	NORQUAY	921.0000	6.3517	4.5743	20.9240	(145)
SPAC	1	204 PLANTS M	134.0000	3.8286	2.0791	4.3227	(35)
COMP	1	MONOCULTURE	63.0000	3.9375	1.1815	1.3958	(16)
COMP	2	MIXTURE	71.0000	3.7368	2.6424	6.9825	(19)
SPAC	2	3 CM SPACING	106.0000	5.0476	1.8021	3.2476	(21)
COMP	1.	MONOCULTURE	56.0000	5.6000	2.0111	4.0444	(10)
COMP	2.	MIXTURE	50.0000	4.5455	1.5076	2.2727	(11)
SPAC	3	9 CM SPACING	104.0000	4.5217	1.5336	2.3518	(23)
COMP	1.	MONOCULTURE	43.0000	4.3000	1.8886	3.5667	(10)
COMP	2	MIXTURE	61.0000	4.6923	1.2506	1.5641	(13)
SPAC	4.	44 PLANTS M	200.0000	7.4074	2.8590	8.1738	(27)
COMP	1.	MONOCULTURE	88.0000	8.0000	2.9665	8.8000	(11)
COMP	2.	MIXTURE	112.0000	7.0000	2.8048	7.8667	(16)
SPAC	5.	28 PLANTS M	80.0000	6.6667	3.5760	12.7879	(12)
COMP	1.	MONOCULTURE	80.0000	6.6667	3.5760	12.7879	(12)

CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	69.0000	8.6250	6.5670	43.1250	(8)
COMP	1.	MONOCULTURE	69.0000	8.6250	6.5670	43.1250	(8)
SPAC	7.	10 PLANTS M	228.0000	12.0000	7.7460	60.0000	(19)
COMP	1.	MONOCULTURE	102.0000	11.3333	6.0000	36.0000	(9)
COMP	2.	MIXTURE	126.0000	12.6000	9.3357	87.1556	(10)
CUL	6.	70M009002	886.0000	6.7634	4.9019	24.0282	(131)
SPAC	1.	204 PLANTS M	61.0000	3.3889	1.2897	1.6634	(18)
COMP	2.	MIXTURE	61.0000	3.3889	1.2897	1.6634	(18)
SPAC	2.	3 CM SPACING	83.0000	3.7727	1.4778	2.1840	(22)
COMP	2.	MIXTURE	83.0000	3.7727	1.4778	2.1840	(22)
SPAC	3.	9 CM SPACING	84.0000	4.6667	2.0864	4.3529	(18)
COMP	2.	MIXTURE	84.0000	4.6667	2.0864	4.3529	(18)
SPAC	4.	44 PLANTS M	80.0000	6.6667	2.3484	5.5152	(12)
COMP	2.	MIXTURE	80.0000	6.6667	2.3484	5.5152	(12)
SPAC	5.	28 PLANTS M	119.0000	6.6111	3.3279	11.0752	(18)
COMP	2.	MIXTURE	119.0000	6.6111	3.3279	11.0752	(18)
SPAC	6.	17 PLANTS M	208.0000	9.4545	4.5327	20.5455	(22)
COMP	2.	MIXTURE	208.0000	9.4545	4.5327	20.5455	(22)
SPAC	7.	10 PLANTS M	251.0000	11.9524	7.3789	54.4476	(21)
COMP	2.	MIXTURE	251.0000	11.9524	7.3789	54.4476	(21)
CUL	7.	NORQUAY	590.0000	8.5507	5.7842	33.4569	(69)
SPAC	1.	204 PLANTS M	40.0000	4.4444	0.8819	0.7778	(9)
COMP	2.	MIXTURE	40.0000	4.4444	0.8819	0.7778	(9)
SPAC	2.	3 CM SPACING	62.0000	5.1667	1.9924	3.9697	(12)
COMP	1.	MONOCULTURE	30.0000	5.0000	2.5298	6.4000	(6)

CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2	MIXTURE	32.0000	5.3333	1.5055	2.2667	(6)
SPAC	3	9 CM SPACING	31.0000	5.1667	2.6394	6.9667	(6)
COMP	1.	MONOCULTURE	31.0000	5.1667	2.6394	6.9667	(6)
SPAC	4	44 PLANTS M	54.0000	7.7143	2.6904	7.2381	(7)
COMP	1	MONOCULTURE	54.0000	7.7143	2.6904	7.2381	(7)
SPAC	5	28 PLANTS M	93.0000	11.6250	3.4200	11.6964	(8)
COMP	2	MIXTURE	93.0000	11.6250	3.4200	11.6964	(8)
SPAC	6	17 PLANTS M	174.0000	11.6000	7.0690	49.9714	(15)
COMP	2	MIXTURE	174.0000	11.6000	7.0690	49.9714	(15)
SPAC	7	10 PLANTS M	136.0000	11.3333	7.9468	63.1515	(12)
COMP	1	MONOCULTURE	72.0000	12.0000	9.6125	92.4000	(6)
COMP	2.	MIXTURE	64.0000	10.6667	6.7429	45.4667	(6)
CUL	8	NB701	1375.0000	7.6188	4.8652	23.6705	(181)
SPAC	1	204 PLANTS M	104.0000	4.1600	1.2477	1.5567	(25)
COMP	2	MIXTURE	104.0000	4.1600	1.2477	1.5567	(25)
SPAC	2	3 CM SPACING	133.0000	4.2903	1.6772	2.8129	(31)
COMP	2	MIXTURE	133.0000	4.2903	1.6772	2.8129	(31)
SPAC	3	9 CM SPACING	131.0000	5.4583	2.0212	4.0851	(24)
COMP	2.	MIXTURE	131.0000	5.4583	2.0212	4.0851	(24)
SPAC	4.	44 PLANTS M	208.0000	6.7097	2.7712	7.6798	(31)
COMP	2	MIXTURE	208.0000	6.7097	2.7712	7.6798	(31)
SPAC	5.	28 PLANTS M	199.0000	11.0556	2.9995	8.9967	(18)
COMP	2	MIXTURE	199.0000	11.0556	2.9995	8.9967	(18)
SPAC	6	17 PLANTS M	255.0000	11.0870	5.4348	29.5375	(23)
COMP	2	MIXTURE	255.0000	11.0870	5.4348	29.5375	(23)

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CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	349.0000	12.0345	6.4834	42.0345	(29)
COMP	2.	MIXTURE	349.0000	12.0345	6.4834	42.0345	(29)

TOTAL CASES = 1080
MISSING CASES = 36 OR 3.3 PCT.

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FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE T TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			10255 0000	9 7760	6.2432	38.9774	(1049)
CUL	2	GLENLEA	2072 0000	11 3846	8.2191	67.5529	(182)
SPAC	1	204 PLANTS M	123 0000	5 1250	3 1112	9.6793	(24)
COMP	1	MONOCULTURE	54.0000	4 9091	2 8794	8.2909	(11)
COMP	2	MIXTURE	69.0000	5.3077	3 4006	11 5641	(13)
SPAC	2	3 CM SPACING	186 0000	5.3143	2.0259	4.1042	(35)
COMP	1	MONOCULTURE	67.0000	4 7857	1.8472	3.4121	(14)
COMP	2	MIXTURE	119.0000	5 6667	2.1055	4.4333	(21)
SPAC	3	9 CM SPACING	249 0000	7 1143	2.6983	7.2807	(35)
COMP	1	MONOCULTURE	80.0000	6 1538	1.6756	2.8077	(13)
COMP	2.	MIXTURE	169.0000	7.6818	3.0455	9.2749	(22)
SPAC	4.	44 PLANTS M	320.0000	11.0345	3.3433	11.1773	(29)
COMP	1.	MONOCULTURE	135.0000	10.3846	1.9807	3.9231	(13)
COMP	2.	MIXTURE	185.0000	11 5625	4.1307	17.0625	(16)
SPAC	5	28 PLANTS M	299.0000	14.9500	6.2448	38.9974	(20)
COMP	1	MONOCULTURE	191.0000	12 7333	4.8766	23 7810	(15)
COMP	2	MIXTURE	108.0000	21.6000	5.3196	28 3000	(5)
SPAC	6	17 PLANTS M	379.0000	18.9500	5.0833	25.8395	(20)
COMP	1	MONOCULTURE	247.0000	19 0000	4.3589	19.0000	(13)
COMP	2.	MIXTURE	132.0000	18.8571	6.6189	43.8095	(7)
SPAC	7.	10 PLANTS M	516.0000	27.1579	7 7263	59 6959	(19)
COMP	1.	MONOCULTURE	195.0000	24.3750	6.3457	40.2679	(8)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	321.0000	29.1818	8.2803	68.5636	(11)
CUL	3.	PARK	1845.0000	8.9130	4.5786	20.9633	(207)
SPAC	1.	204 PLANTS M	134.0000	5.3600	2.2338	4.9900	(25)
COMP	1.	MONOCULTURE	33.0000	5.5000	1.8708	3.5000	(6)
COMP	2.	MIXTURE	101.0000	5.3158	2.3817	5.6725	(19)
SPAC	2.	3 CM SPACING	269.0000	6.5610	3.1547	9.9524	(41)
COMP	1.	MONOCULTURE	114.0000	8.1429	3.0091	9.0549	(14)
COMP	2.	MIXTURE	155.0000	5.7407	2.9560	8.7378	(27)
SPAC	3.	9 CM SPACING	251.0000	7.8438	3.0279	9.1683	(32)
COMP	1.	MONOCULTURE	101.0000	8.4167	3.0588	9.3561	(12)
COMP	2.	MIXTURE	150.0000	7.5000	3.0349	9.2105	(20)
SPAC	4.	44 PLANTS M	245.0000	8.7500	3.8646	14.9352	(28)
COMP	1.	MONOCULTURE	99.0000	9.0000	4.3359	18.8000	(11)
COMP	2.	MIXTURE	146.0000	8.5882	3.6582	13.3824	(17)
SPAC	5.	28 PLANTS M	304.0000	10.4828	2.6271	6.9015	(29)
COMP	1.	MONOCULTURE	155.0000	10.3333	3.1091	9.6667	(15)
COMP	2.	MIXTURE	149.0000	10.6429	2.0979	4.4011	(14)
SPAC	6.	17 PLANTS M	317.0000	12.1923	5.6001	31.3615	(26)
COMP	1.	MONOCULTURE	165.0000	12.6923	5.4219	29.3974	(13)
COMP	2.	MIXTURE	152.0000	11.6923	5.9496	35.3974	(13)
SPAC	7.	10 PLANTS M	325.0000	12.5000	5.9008	34.8200	(26)
COMP	1.	MONOCULTURE	154.0000	11.8462	6.1488	37.8077	(13)
COMP	2.	MIXTURE	171.0000	13.1538	5.8144	33.8077	(13)
CUL	4.	70M009002	1259.0000	9.6107	5.0833	25.8396	(131)
SPAC	1.	204 PLANTS M	115.0000	5.7500	3.4009	11.5658	(20)
COMP	2.	MIXTURE	115.0000	5.7500	3.4009	11.5658	(20)
SPAC	2.	3 CM SPACING	142.0000	6.1739	2.9795	8.8775	(23)
COMP	2.	MIXTURE	142.0000	6.1739	2.9795	8.8775	(23)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	189.0000	9.4500	3.8317	14.6818	(20)
COMP	2.	MIXTURE	189.0000	9.4500	3.8317	14.6818	(20)
SPAC	4.	44 PLANTS M	146.0000	8.5882	2.5995	6.7574	(17)
COMP	2.	MIXTURE	146.0000	8.5882	2.5995	6.7574	(17)
SPAC	5.	28 PLANTS M	229.0000	12.0526	3.7635	14.1637	(19)
COMP	2.	MIXTURE	229.0000	12.0526	3.7635	14.1637	(19)
SPAC	6.	17 PLANTS M	256.0000	12.8000	4.0079	16.0632	(20)
COMP	2.	MIXTURE	256.0000	12.8000	4.0079	16.0632	(20)
SPAC	7.	10 PLANTS M	182.0000	15.1667	8.0998	65.6061	(12)
COMP	2.	MIXTURE	182.0000	15.1667	8.0998	65.6061	(12)
CUL	5.	NORQUAY	1181.0000	8.0890	5.9792	35.7506	(146)
SPAC	1.	204 PLANTS M	152.0000	4.3429	2.3256	5.4084	(35)
COMP	1.	MONOCULTURE	68.0000	4.2500	1.1832	1.4000	(16)
COMP	2.	MIXTURE	84.0000	4.4211	3.0058	9.0351	(19)
SPAC	2.	3 CM SPACING	129.0000	5.8636	3.1667	10.0281	(22)
COMP	1.	MONOCULTURE	73.0000	7.3000	3.9455	15.5667	(10)
COMP	2.	MIXTURE	56.0000	4.6667	1.7233	2.9697	(12)
SPAC	3.	9 CM SPACING	144.0000	6.2609	2.5265	6.3834	(23)
COMP	1.	MONOCULTURE	53.0000	5.3000	2.3594	5.5667	(10)
COMP	2.	MIXTURE	91.0000	7.0000	2.4833	6.1667	(13)
SPAC	4.	44 PLANTS M	253.0000	9.3704	3.8245	14.6268	(27)
COMP	1.	MONOCULTURE	107.0000	9.7273	4.1735	17.4182	(11)
COMP	2.	MIXTURE	146.0000	9.1250	3.6856	13.5833	(16)
SPAC	5.	28 PLANTS M	105.0000	8.7500	4.5352	20.5682	(12)
COMP	1.	MONOCULTURE	105.0000	8.7500	4.5352	20.5682	(12)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	86.0000	10.7500	7.3241	53.6429	(8)
COMP	1.	MONOCULTURE	86.0000	10.7500	7.3241	53.6429	(8)
SPAC	7.	10 PLANTS M	312.0000	16.4211	9.3233	86.9240	(19)
COMP	1.	MONOCULTURE	132.0000	14.6667	8.7034	75.7500	(9)
COMP	2.	MIXTURE	180.0000	18.0000	10.0333	100.6667	(10)
CUL	6.	70M009002	1246.0000	9.5115	6.1135	37.3749	(131)
SPAC	1.	204 PLANTS M	76.0000	4.2222	2.1020	4.4183	(18)
COMP	2.	MIXTURE	76.0000	4.2222	2.1020	4.4183	(18)
SPAC	2.	3 CM SPACING	105.0000	4.7727	1.7977	3.2316	(22)
COMP	2.	MIXTURE	105.0000	4.7727	1.7977	3.2316	(22)
SPAC	3.	9 CM SPACING	113.0000	6.2778	2.9467	8.6830	(18)
COMP	2.	MIXTURE	113.0000	6.2778	2.9467	8.6830	(18)
SPAC	4.	44 PLANTS M	123.0000	10.2500	3.4145	11.6591	(12)
COMP	2.	MIXTURE	123.0000	10.2500	3.4145	11.6591	(12)
SPAC	5.	28 PLANTS M	176.0000	9.7778	4.2779	18.3007	(18)
COMP	2.	MIXTURE	176.0000	9.7778	4.2779	18.3007	(18)
SPAC	6.	17 PLANTS M	309.0000	14.0455	6.2066	38.5216	(22)
COMP	2.	MIXTURE	309.0000	14.0455	6.2066	38.5216	(22)
SPAC	7.	10 PLANTS M	344.0000	16.3810	5.8436	34.1476	(21)
COMP	2.	MIXTURE	344.0000	16.3810	5.8436	34.1476	(21)
CUL	7.	NORQUAY	840.0000	12.1739	7.1413	50.9987	(69)
SPAC	1.	204 PLANTS M	40.0000	4.4444	0.8819	0.7778	(9)
COMP	2.	MIXTURE	40.0000	4.4444	0.8819	0.7778	(9)
SPAC	2.	3 CM SPACING	80.0000	6.6667	3.2845	10.7879	(12)
COMP	1.	MONOCULTURE	46.0000	7.6667	4.3665	19.0667	(6)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	34.0000	5.6667	1.5055	2.2667	(6)
SPAC	3.	9 CM SPACING	47.0000	7.8333	3.9707	15.7667	(6)
COMP	1.	MONOCULTURE	47.0000	7.8333	3.9707	15.7667	(6)
SPAC	4.	44 PLANTS M	90.0000	12.8571	2.8536	8.1429	(7)
COMP	1.	MONOCULTURE	90.0000	12.8571	2.8536	8.1429	(7)
SPAC	5.	28 PLANTS M	132.0000	16.5000	3.6645	13.4286	(8)
COMP	2.	MIXTURE	132.0000	16.5000	3.6645	13.4286	(8)
SPAC	6.	17 PLANTS M	223.0000	14.8667	5.9865	35.8381	(15)
COMP	2.	MIXTURE	223.0000	14.8667	5.9865	35.8381	(15)
SPAC	7.	10 PLANTS M	228.0000	19.0000	8.4423	71.2727	(12)
COMP	1.	MONOCULTURE	112.0000	18.6667	8.9368	79.8667	(6)
COMP	2.	MIXTURE	116.0000	19.3333	8.7560	76.6667	(6)
CUL	8.	NB701	1812.0000	9.9016	5.7322	32.8584	(183)
SPAC	1.	204 PLANTS M	140.0000	5.6000	1.8028	3.2500	(25)
COMP	2.	MIXTURE	140.0000	5.6000	1.8028	3.2500	(25)
SPAC	2.	3 CM SPACING	174.0000	5.4375	2.2992	5.2863	(32)
COMP	2.	MIXTURE	174.0000	5.4375	2.2992	5.2863	(32)
SPAC	3.	9 CM SPACING	166.0000	6.9167	2.9180	8.5145	(24)
COMP	2.	MIXTURE	166.0000	6.9167	2.9180	8.5145	(24)
SPAC	4.	44 PLANTS M	274.0000	8.8387	3.6615	13.4065	(31)
COMP	2.	MIXTURE	274.0000	8.8387	3.6615	13.4065	(31)
SPAC	5.	28 PLANTS M	229.0000	12.7222	3.3220	11.0359	(18)
COMP	2.	MIXTURE	229.0000	12.7222	3.3220	11.0359	(18)
SPAC	6.	17 PLANTS M	364.0000	15.1667	6.0982	37.1884	(24)
COMP	2.	MIXTURE	364.0000	15.1667	6.0982	37.1884	(24)

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CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	465.0000	16.0345	5.5064	30.3202	(29)
COMP	2.	MIXTURE	465.0000	16.0345	5.5064	30.3202	(29)

TOTAL CASES = 1080
MISSING CASES = 31 OR 2.9 PCT.

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FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE WT DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			48123 3225	46.0510	28 6956	823.4360	(1045)
CUL	2.	GLENLEA	10524.2487	58.1450	35.9136	1289 7875	(181)
SPAC	1	204 PLANTS M	744 4899	31 0204	14.9501	223 5063	(24)
COMP	1	MONOCULTURE	367.2699	33.3882	16.5910	275.2615	(11)
COMP	2	MIXTURE	377.2199	29.0169	13 7664	189.5149	(13)
SPAC	2	3 CM SPACING	1130.3898	32.2969	7.8575	61.7404	(35)
COMP	1.	MONOCULTURE	438.8499	31.3464	8.0405	64.6502	(14)
COMP	2.	MIXTURE	691.5399	32.9305	7 8665	61.8822	(21)
SPAC	3.	9 CM SPACING	1336.4097	38.1831	10.2451	104.9626	(35)
COMP	1.	MONOCULTURE	469.9899	36.1531	8.6787	75.3197	(13)
COMP	2.	MIXTURE	866 4198	39.3827	11.0834	122.8410	(22)
SPAC	4.	44 PLANTS M	1529 3898	54.6211	12.2450	149 9397	(28)
COMP	1.	MONOCULTURE	700.5199	53.8861	6.8672	47.1582	(13)
COMP	2.	MIXTURE	828.8699	55.2580	15.7420	247.8120	(15)
SPAC	5.	28 PLANTS M	1443.9398	72.1970	22.4485	503.9366	(20)
COMP	1.	MONOCULTURE	987.7299	65.8487	19.4982	380.1800	(15)
COMP	2	MIXTURE	456.2100	91.2420	21.4138	458.5490	(5)
SPAC	6	17 PLANTS M	1970 4699	98.5235	31.4351	988.1651	(20)
COMP	1.	MONOCULTURE	1289 6299	99.2023	23.5552	554.8469	(13)
COMP	2.	MIXTURE	680.8400	97.2629	44.9071	2016.6433	(7)
SPAC	7.	10 PLANTS M	2369 1599	124.6926	26.7888	717.6381	(19)
COMP	1.	MONOCULTURE	955.1099	119.3887	19.9641	398.5637	(8)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	1414.0500	128.5500	31.2071	973.8818	(11)
CUL	3.	PARK	7562.2286	36.7098	13.3610	178.5160	(206)
SPAC	1.	204 PLANTS M	627.3499	25.0940	5.4300	29.4851	(25)
COMP	1.	MONOCULTURE	145.8400	24.3067	5.0098	25.0979	(6)
COMP	2.	MIXTURE	481.5099	25.3426	5.6630	32.0700	(19)
SPAC	2.	3 CM SPACING	1131.6098	27.6002	7.3953	54.6905	(41)
COMP	1.	MONOCULTURE	422.1199	30.1514	6.5427	42.8073	(14)
COMP	2.	MIXTURE	709.4898	26.2774	7.5772	57.4138	(27)
SPAC	3.	9 CM SPACING	1033.0798	32.2837	6.3310	40.0813	(32)
COMP	1.	MONOCULTURE	409.8099	34.1508	6.1031	37.2474	(12)
COMP	2.	MIXTURE	623.2699	31.1635	6.3489	40.3088	(20)
SPAC	4.	44 PLANTS M	1003.2298	37.1567	8.9810	80.6585	(27)
COMP	1.	MONOCULTURE	412.4099	37.4918	9.7408	94.8835	(11)
COMP	2.	MIXTURE	590.8199	36.9262	8.7415	76.4135	(16)
SPAC	5.	28 PLANTS M	1354.3298	46.7010	9.1787	84.2480	(29)
COMP	1.	MONOCULTURE	691.8399	46.1227	10.9438	119.7674	(15)
COMP	2.	MIXTURE	662.4899	47.3207	7.1887	51.6773	(14)
SPAC	6.	17 PLANTS M	1224.0398	47.0785	17.3340	300.4669	(26)
COMP	1.	MONOCULTURE	632.8699	48.6823	15.5764	242.6252	(13)
COMP	2.	MIXTURE	591.1699	45.4746	19.4364	377.7742	(13)
SPAC	7.	10 PLANTS M	1188.5898	45.7150	14.5381	211.3555	(26)
COMP	1.	MONOCULTURE	560.7299	43.1331	16.5958	275.4217	(13)
COMP	2.	MIXTURE	627.8599	48.2969	12.2662	150.4586	(13)
CUL	4.	70M009002	4683.7391	35.7537	15.8020	249.7017	(131)
SPAC	1.	204 PLANTS M	449.6099	22.4805	5.2118	27.1627	(20)
COMP	2.	MIXTURE	449.6099	22.4805	5.2118	27.1627	(20)
SPAC	2.	3 CM SPACING	577.3498	25.1022	6.4300	41.3443	(23)
COMP	2	MIXTURE	577.3498	25.1022	6.4300	41.3443	(23)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3	9 CM SPACING	640.2999	32.0150	9.7604	95.2654	(20)
COMP	2.	MIXTURE	640.2999	32.0150	9.7604	95.2654	(20)
SPAC	4.	44 PLANTS M	554.8299	32.6371	8.0514	64.8251	(17)
COMP	2.	MIXTURE	554.8299	32.6371	8.0514	64.8251	(17)
SPAC	5.	28 PLANTS M	855.3399	45.0179	11.7602	138.3033	(19)
COMP	2	MIXTURE	855.3399	45.0179	11.7602	138.3033	(19)
SPAC	6	17 PLANTS M	939.3999	46.9700	14.8408	220.2490	(20)
COMP	2	MIXTURE	939.3999	46.9700	14.8408	220.2490	(20)
SPAC	7	10 PLANTS M	666.9099	55.5758	23.4997	552.2382	(12)
COMP	2	MIXTURE	666.9099	55.5758	23.4997	552.2382	(12)
CUL	5	NORQUAY	5570.4690	38.1539	23.5806	556.0454	(146)
SPAC	1	204 PLANTS M	847.5598	24.2160	7.1483	51.0984	(35)
COMP	1	MONOCULTURE	382.1299	23.8831	4.7380	22.4489	(16)
COMP	2.	MIXTURE	465.4299	24.4963	8.8108	77.6302	(19)
SPAC	2	3 CM SPACING	634.2499	28.8295	9.1068	82.9334	(22)
COMP	1.	MONOCULTURE	332.2199	33.2220	10.8547	117.8240	(10)
COMP	2.	MIXTURE	302.0300	25.1692	5.4562	29.7700	(12)
SPAC	3.	9 CM SPACING	654.4998	28.4565	7.4171	55.0131	(23)
COMP	1.	MONOCULTURE	258.7299	25.8730	8.1000	65.6092	(10)
COMP	2.	MIXTURE	395.7699	30.4438	6.4660	41.8098	(13)
SPAC	4	44 PLANTS M	1093.0898	40.4848	10.9544	119.9978	(27)
COMP	1.	MONOCULTURE	476.1999	43.2909	12.0082	144.1965	(11)
COMP	2.	MIXTURE	616.8899	38.5556	10.1055	102.1210	(16)
SPAC	5.	28 PLANTS M	467.3499	38.9458	16.2895	265.3469	(12)
COMP	1	MONOCULTURE	467.3499	38.9458	16.2895	265.3469	(12)

CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	461.6400	57.7050	29.6408	878.5753	(8)
COMP	1.	MONOCULTURE	461.6400	57.7050	29.6408	878.5753	(8)
SPAC	7.	10 PLANTS M	1412.0799	74.3200	37.1257	1378.3159	(19)
COMP	1.	MONOCULTURE	596.1699	66.2411	28.0936	789.2514	(9)
COMP	2.	MIXTURE	815.9099	81.5910	43.9439	1931.0649	(10)
CUL	6.	70M009002	6752.2690	51.9405	42.0296	1766.4887	(130)
SPAC	1.	204 PLANTS M	620.1198	34.4511	41.7618	1744.0480	(18)
COMP	2.	MIXTURE	620.1198	34.4511	41.7618	1744.0480	(18)
SPAC	2.	3 CM SPACING	1050.0097	50.0005	75.5840	5712.9373	(21)
COMP	2.	MIXTURE	1050.0097	50.0005	75.5840	5712.9373	(21)
SPAC	3.	9 CM SPACING	550.6599	30.5922	6.1202	37.4565	(18)
COMP	2.	MIXTURE	550.6599	30.5922	6.1202	37.4565	(18)
SPAC	4.	44 PLANTS M	575.0299	47.9192	20.1915	407.6971	(12)
COMP	2.	MIXTURE	575.0299	47.9192	20.1915	407.6971	(12)
SPAC	5.	28 PLANTS M	799.3198	44.4067	13.4081	179.7766	(18)
COMP	2.	MIXTURE	799.3198	44.4067	13.4081	179.7766	(18)
SPAC	6.	17 PLANTS M	1462.5299	66.4786	33.8083	1143.0029	(22)
COMP	2.	MIXTURE	1462.5299	66.4786	33.8083	1143.0029	(22)
SPAC	7.	10 PLANTS M	1694.5999	80.6952	27.1766	738.5670	(21)
COMP	2.	MIXTURE	1694.5999	80.6952	27.1766	738.5670	(21)
CUL	7.	NORQUAY	3486.9396	50.5354	26.9674	727.2431	(69)
SPAC	1.	204 PLANTS M	231.1999	25.6889	4.5545	20.7431	(9)
COMP	2.	MIXTURE	231.1999	25.6889	4.5545	20.7431	(9)
SPAC	2.	3 CM SPACING	341.2099	28.4342	8.6139	74.1991	(12)
COMP	1.	MONOCULTURE	172.6600	28.7767	11.8215	139.7475	(6)

CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2	MIXTURE	168.5499	28 0917	4.8176	23.2090	(6)
SPAC	3.	9 CM SPACING	182 4900	30.4150	12.6946	161.1541	(6)
COMP	1.	MONOCULTURE	182 4900	30.4150	12 6946	161 1541	(6)
SPAC	4.	44 PLANTS M	313.7800	44.8257	8 9777	80.5994	(7
COMP	1	MONOCULTURE	313 7800	44 8257	8 9777	80 5994	(7
SPAC	5	28 PLANTS M	564 6500	70.5812	6 7319	45 3179	(8)
COMP	2.	MIXTURE	564.6500	70.5812	6 7319	45 3179	(8)
SPAC	6	17 PLANTS M	945 9099	63.0607	21 7389	472 5801	(15)
COMP	2.	MIXTURE	945 9099	63.0607	21 7389	472 5801	(15)
SPAC	7	10 PLANTS M	907.6999	75 6417	34 4317	1185 5417	(12)
COMP	1.	MONOCULTURE	462 6400	77 1067	39 8699	1589 6057	(6)
COMP	2	MIXTURE	445.0600	74 1767	31 8345	1013 4350	(6)
CUL	8.	NB701	9543 4286	52 4364	25 7195	661 4924	(182)
SPAC	1.	204 PLANTS M	786 7798	31 4712	4 3532	18.9501	(25)
COMP	2	MIXTURE	786 7798	31.4712	4 3532	18.9501	(25)
SPAC	2.	3 CM SPACING	960.4898	30.9835	6 7346	45.3548	(31)
COMP	2.	MIXTURE	960.4898	30 9835	6.7346	45.3548	(31)
SPAC	3.	9 CM SPACING	919.9198	38.3300	9.5233	90 6930	(24)
COMP	2.	MIXTURE	919.9198	38.3300	9 5233	90.6930	(24)
SPAC	4.	44 PLANTS M	1439.9397	46.4497	11.2068	125.5931	(31)
COMP	2.	MIXTURE	1439.9397	46.4497	11.2068	125 5931	(31)
SPAC	5	28 PLANTS M	1220.5599	67.8089	12.3869	153.4348	(18)
COMP	2.	MIXTURE	1220.5599	67.8089	12.3869	153 4348	(18
SPAC	6.	17 PLANTS M	1844.6998	76 8625	28.0851	788 7731	(24)
COMP	2.	MIXTURE	1844.6998	76.8625	28.0851	788 7731	(24

CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	2371.0398	81.7600	24.3921	594.9743	(29)
COMP	2.	MIXTURE	2371.0398	81.7600	24.3921	594.9743	(29)

TOTAL CASES = 1080
MISSING CASES = 35 OR 3.2 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE Y SEED YIELD PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14804.4174	14.3038	12.8480	165.0699	(1035)
CUL	2.	GLENLEA	3629.4494	20.1636	18.2231	332.0818	(180)
SPAC	1.	204 PLANTS M	177 2400	7.7061	5.8273	33 9578	(23)
COMP	1.	MONOCULTURE	84.8500	7.7136	7.2159	52.0696	(11)
COMP	2.	MIXTURE	92.3900	7.6992	4 5365	20.5796	(12)
SPAC	2.	3 CM SPACING	271.7100	7.9915	3.1188	9.7266	(34)
COMP	1.	MONOCULTURE	94.4900	7.2685	3.2433	10.5188	(13)
COMP	2.	MIXTURE	177.2200	8.4390	3.0311	9.1875	(21)
SPAC	3.	9 CM SPACING	361.2100	10.3203	4.1691	17.3817	(35)
COMP	1.	MONOCULTURE	112.5600	8.6585	3.8726	14.9968	(13)
COMP	2.	MIXTURE	248.6500	11.3023	4.1052	16.8523	(22)
SPAC	4.	44 PLANTS M	496.0099	17.1038	5.3600	28.7300	(29)
COMP	1.	MONOCULTURE	217.0400	16.6954	3.2172	10.3503	(13)
COMP	2.	MIXTURE	278.9699	17.4356	6.7147	45.0870	(16)
SPAC	5.	28 PLANTS M	510.1399	25.5070	9.6354	92.8402	(20)
COMP	1.	MONOCULTURE	335.2999	22.3533	8.3744	70.1305	(15)
COMP	2.	MIXTURE	174.8400	34.9680	6.8081	46.3501	(5)
SPAC	6.	17 PLANTS M	751.3498	37.5675	15.4142	237.5986	(20
COMP	1.	MONOCULTURE	473.5899	36.4300	12.3287	151.9979	(13)
COMP	2.	MIXTURE	277.7600	39.6800	20.9855	440.3899	(7)
SPAC	7.	10 PLANTS M	1061.7898	55.8837	20.4937	419.9902	(19)
COMP	1.	MONOCULTURE	353.3099	44.1637	15.3776	236.4694	(8)

CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	708.4799	64.4073	20.0163	400.6516	(11)
CUL	3.	PARK	1974.4497	9.5384	5.6860	32.3307	(207)
SPAC	1.	204 PLANTS M	114.7000	4.5880	2.4793	6.1467	(25)
COMP	1.	MONOCULTURE	24.7400	4.1233	2.2404	5.0193	(6)
COMP	2.	MIXTURE	89.9600	4.7347	2.5897	6.7066	(19)
SPAC	2.	3 CM SPACING	219.2900	5.3485	3.1345	9.8251	(41)
COMP	1.	MONOCULTURE	91.2700	6.5193	2.7445	7.5323	(14)
COMP	2.	MIXTURE	128.0200	4.7415	3.1982	10.2286	(27)
SPAC	3.	9 CM SPACING	241.1400	7.5356	2.9739	8.8440	(32)
COMP	1.	MONOCULTURE	100.0100	8.3342	2.5921	6.7188	(12)
COMP	2.	MIXTURE	141.1300	7.0565	3.1457	9.8955	(20)
SPAC	4.	44 PLANTS M	288.3400	10.2979	4.0280	16.2246	(28)
COMP	1.	MONOCULTURE	106.3500	9.6682	3.8544	14.8560	(11)
COMP	2.	MIXTURE	181.9900	10.7053	4.2006	17.6451	(17)
SPAC	5.	28 PLANTS M	407.3099	14.0452	4.7749	22.7993	(29)
COMP	1.	MONOCULTURE	195.8200	13.0547	5.4038	29.2006	(15)
COMP	2.	MIXTURE	211.4900	15.1064	3.9134	15.3145	(14)
SPAC	6.	17 PLANTS M	361.5399	13.9054	6.1601	37.9464	(26)
COMP	1.	MONOCULTURE	200.2800	15.4062	6.7272	45.2554	(13)
COMP	2.	MIXTURE	161.2600	12.4046	5.3777	28.9196	(13)
SPAC	7.	10 PLANTS M	342.1299	13.1588	6.0589	36.7102	(26)
COMP	1.	MONOCULTURE	157.2300	12.0946	7.0121	49.1693	(13)
COMP	2.	MIXTURE	184.9000	14.2231	4.9856	24.8563	(13)
CUL	4.	70M009002	1315.8498	10.2004	7.2785	52.9764	(129)
SPAC	1.	204 PLANTS M	84.5700	4.2285	1.9592	3.8384	(20)
COMP	2.	MIXTURE	84.5700	4.2285	1.9592	3.8384	(20)
SPAC	2.	3 CM SPACING	119.5600	5.4345	2.3782	5.6557	(22)
COMP	2.	MIXTURE	119.5600	5.4345	2.3782	5.6557	(22)

CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	164.2000	8.2100	4.1276	17.0370	(20)
COMP	2	MIXTURE	164.2000	8.2100	4.1276	17.0370	(20)
SPAC	4	44 PLANTS M	151.7400	8.9259	3.3288	11.0808	(17)
COMP	2	MIXTURE	151.7400	8.9259	3.3288	11.0808	(17)
SPAC	5.	28 PLANTS M	263.4400	13.8653	4.5644	20.8337	(19)
COMP	2	MIXTURE	263.4400	13.8653	4.5644	20.8337	(19)
SPAC	6	17 PLANTS M	319.9699	15.9985	7.3135	53.4877	(20)
COMP	2.	MIXTURE	319.9699	15.9985	7.3135	53.4877	(20)
SPAC	7	10 PLANTS M	212.3700	19.3064	12.3998	153.7548	(11)
COMP	2	MIXTURE	212.3700	19.3064	12.3998	153.7548	(11)
CUL	5	NOROUAY	1745.2997	12.0365	11.6010	134.5840	(145)
SPAC	1	204 PLANTS M	186.3400	5.3240	3.3414	11.1650	(35)
COMP	1	MONOCULTURE	92.3700	5.7731	2.2704	5.1546	(16)
COMP	2	MIXTURE	93.9700	4.9458	4.0575	16.4637	(19)
SPAC	2.	3 CM SPACING	147.0100	7.0005	3.9960	15.9676	(21)
COMP	1.	MONOCULTURE	81.9800	9.1089	4.6686	21.7959	(9)
COMP	2.	MIXTURE	65.0300	5.4192	2.6106	6.8155	(12)
SPAC	3.	9 CM SPACING	165.3800	7.1904	2.8063	7.8754	(23)
COMP	1.	MONOCULTURE	70.5400	7.0540	3.1983	10.2286	(10)
COMP	2.	MIXTURE	94.8400	7.2954	2.5960	6.7392	(13)
SPAC	4.	44 PLANTS M	349.5199	12.9452	5.6204	31.5890	(27)
COMP	1.	MONOCULTURE	165.1599	15.0145	6.1511	37.8356	(11)
COMP	2.	MIXTURE	184.3600	11.5225	4.9225	24.2313	(16)
SPAC	5.	28 PLANTS M	164.5100	13.7092	7.4881	56.0715	(12)
COMP	1	MONOCULTURE	164.5100	13.7092	7.4881	56.0715	(12)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	163.8000	20.4750	16.6208	276.2495	(8)
COMP	1.	MONOCULTURE	163.8000	20.4750	16.6208	276.2495	(8)
SPAC	7.	10 PLANTS M	568.7399	29.9337	17.9116	320.8261	(19)
COMP	1.	MONOCULTURE	233.2700	25.9189	13.3391	177.9309	(9)
COMP	2.	MIXTURE	335.4699	33.5470	21.2806	452.8660	(10)
CUL	6.	70M009002	1983.0896	15.4929	14.9345	223.0407	(128)
SPAC	1.	204 PLANTS M	88.6500	4.9250	2.0799	4.3261	(18)
COMP	2.	MIXTURE	88.6500	4.9250	2.0799	4.3261	(18)
SPAC	2.	3 CM SPACING	121.0500	5.5023	2.4944	6.2221	(22)
COMP	2.	MIXTURE	121.0500	5.5023	2.4944	6.2221	(22)
SPAC	3.	9 CM SPACING	111.1200	6.9450	3.1230	9.7530	(16)
COMP	2.	MIXTURE	111.1200	6.9450	3.1230	9.7530	(16)
SPAC	4.	44 PLANTS M	179.3000	14.9417	8.9519	80.1366	(12)
COMP	2.	MIXTURE	179.3000	14.9417	8.9519	80.1366	(12)
SPAC	5.	28 PLANTS M	254.4299	14.1350	7.1222	50.7254	(18)
COMP	2.	MIXTURE	254.4299	14.1350	7.1222	50.7254	(18)
SPAC	6.	17 PLANTS M	555.9799	25.2718	18.4032	338.6769	(22)
COMP	2.	MIXTURE	555.9799	25.2718	18.4032	338.6769	(22)
SPAC	7.	10 PLANTS M	672.5599	33.6280	16.2645	264.5344	(20)
COMP	2.	MIXTURE	672.5599	33.6280	16.2645	264.5344	(20)
CUL	7.	NORQUAY	1098.7598	16.9040	12.3833	153.3473	(65)
SPAC	1.	204 PLANTS M	41.9400	5.2425	1.9082	3.6414	(8)
COMP	2.	MIXTURE	41.9400	5.2425	1.9082	3.6414	(8)
SPAC	2.	3 CM SPACING	86.5300	7.8664	4.3158	18.6262	(11)
COMP	1.	MONOCULTURE	53.7000	8.9500	5.4340	29.5280	(6)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	32.8300	6.5660	2.4042	5.7803	(5)
SPAC	3.	9 CM SPACING	62.7000	10.4500	6.2299	38.8114	(6)
COMP	1.	MONOCULTURE	62.7000	10.4500	6.2299	38.8114	(6)
SPAC	4.	44 PLANTS M	82.8100	13.8017	5.6807	32 2708	(6)
COMP	1.	MONOCULTURE	82.8100	13.8017	5.6807	32.2708	(6)
SPAC	5.	28 PLANTS M	175 5999	25.0857	4.9738	24 7390	(7)
COMP	2.	MIXTURE	175 5999	25.0857	4.9738	24.7390	(7)
SPAC	6.	17 PLANTS M	307.6199	20.5080	9.3253	86 9605	(15)
COMP	2.	MIXTURE	307.6199	20.5080	9.3253	86 9605	(15)
SPAC	7.	10 PLANTS M	341.5599	28.4633	17.3737	301.8448	(12)
COMP	1.	MONOCULTURE	198.7900	33 1317	20.3637	414.6803	(6)
COMP	2.	MIXTURE	142.7700	23 7950	14.0383	197.0743	(6)
CUL	8.	NB701	3057.5194	16.8924	11.7013	136.9213	(181)
SPAC	1.	204 PLANTS M	187.8700	7.5148	2.2240	4.9462	(25)
COMP	2.	MIXTURE	187.8700	7.5148	2.2240	4.9462	(25)
SPAC	2.	3 CM SPACING	232.6900	7.2716	3.1041	9.6357	(32)
COMP	2.	MIXTURE	232.6900	7.2716	3.1041	9.6357	(32)
SPAC	3.	9 CM SPACING	261.0000	10.8750	4.1693	17.3830	(24)
COMP	2.	MIXTURE	261.0000	10.8750	4.1693	17.3830	(24)
SPAC	4.	44 PLANTS M	432.5399	14.4180	5.4080	29.2466	(30)
COMP	2.	MIXTURE	432.5399	14.4180	5.4080	29.2466	(30)
SPAC	5.	28 PLANTS M	440.8699	24.4928	6.5769	43.2553	(18)
COMP	2.	MIXTURE	440.8699	24.4928	6.5769	43.2553	(18)
SPAC	6.	17 PLANTS M	659.0599	28.6548	12.9021	166.4636	(23)
COMP	2.	MIXTURE	659.0599	28.6548	12.9021	166.4636	(23)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	843.4898	29.0859	11.7049	137.0054	(29)
COMP	2	MIXTURE	843.4898	29.0859	11.7049	137.0054	(29)

TOTAL CASES = 1080
MISSING CASES = 45 OR 4.2 PCT.

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FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE NK NUMBER OF KERNELS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			361302 0000	350.0988	312.3564	97566.5101	(1032)
CUL	2	GLENLEA	72336.0000	406.3820	377 6956	142653 9549	(178)
SPAC	1	204 PLANTS M	3557.0000	154.6522	134.2100	18012.3281	(23)
COMP	1	MONOCULTURE	1763 0000	160 2727	174 4758	30441.8182	(11)
COMP	2	MIXTURE	1794 0000	149.5000	91.0479	8289.7273	(12)
SPAC	2	3 CM SPACING	5289 0000	155.5588	54.6710	2988 9207	(34)
COMP	1	MONOCULTURE	1846.0000	142 0000	57.8158	3342.6667	(13)
COMP	2	MIXTURE	3443.0000	163.9524	52.2747	2732.6476	(21)
SPAC	3	9 CM SPACING	7090.0000	202.5714	75.2917	5668.8403	(35)
COMP	1.	MONOCULTURE	2291.0000	176.2308	73.3134	5374.8590	(13)
COMP	2.	MIXTURE	4799.0000	218.1364	73.6441	5423 4567	(22)
SPAC	4	44 PLANTS M	9353.0000	334.0357	96.4559	9303.7394	(28)
COMP	1.	MONOCULTURE	4405.0000	338.8462	68.3165	4667.1410	(13)
COMP	2.	MIXTURE	4948 0000	329.8667	117.9085	13902.4095	(15)
SPAC	5	28 PLANTS M	10684 0000	534.2000	205.1432	42083.7474	(20)
COMP	1.	MONOCULTURE	7045.0000	469.6667	179.0920	32073.9524	(15)
COMP	2.	MIXTURE	3639.0000	727.8000	158.6528	25170 7000	(5)
SPAC	6.	17 PLANTS M	14590.0000	767.8947	303.3721	92034.6550	(19)
COMP	1.	MONOCULTURE	8855.0000	737.9167	242.8192	58961.1742	(12)
COMP	2.	MIXTURE	5735.0000	819.2857	403.8934	163129.9048	(7)
SPAC	7	10 PLANTS M	21773 0000	1145.9474	438.1611	191985.1637	(19)
COMP	1.	MONOCULTURE	6964.0000	870.5000	296.1510	87705.4286	(8)

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	14809.0000	1346.2727	423.4846	179339.2182	(11)
CUL	3.	PARK	56013.0000	270.5942	171.7566	29500.3200	(207)
SPAC	1.	204 PLANTS M	2995.0000	119.8000	58.7324	3449.5000	(25)
COMP	1.	MONOCULTURE	677.0000	112.8333	59.5766	3549.3667	(6)
COMP	2.	MIXTURE	2318.0000	122.0000	59.9342	3592.1111	(19)
SPAC	2.	3 CM SPACING	5930.0000	144.6341	80.3772	6460.4878	(41)
COMP	1.	MONOCULTURE	2466.0000	176.1429	72.0233	5187.3626	(14)
COMP	2.	MIXTURE	3464.0000	128.2963	80.8316	6533.7550	(27)
SPAC	3.	9 CM SPACING	6796.0000	212.3750	82.1771	6753.0806	(32)
COMP	1.	MONOCULTURE	2937.0000	244.7500	90.0930	8116.7500	(12)
COMP	2.	MIXTURE	3859.0000	192.9500	72.5248	5259.8395	(20)
SPAC	4.	44 PLANTS M	7985.0000	285.1786	124.9305	15607.6336	(28)
COMP	1.	MONOCULTURE	3155.0000	286.8182	131.4419	17276.9636	(11)
COMP	2.	MIXTURE	4830.0000	284.1176	124.6464	15536.7353	(17)
SPAC	5.	28 PLANTS M	11576.0000	399.1724	127.1740	16173.2192	(29)
COMP	1.	MONOCULTURE	5701.0000	380.0667	132.4373	17539.6381	(15)
COMP	2.	MIXTURE	5875.0000	419.6428	122.7735	15073.3242	(14)
SPAC	6.	17 PLANTS M	10647.0000	409.5000	200.3623	40145.0600	(26)
COMP	1.	MONOCULTURE	5617.0000	432.0769	169.6125	28768.4103	(13)
COMP	2.	MIXTURE	5030.0000	386.9231	231.8679	53762.7436	(13)
SPAC	7.	10 PLANTS M	10084.0000	387.8462	197.6546	39067.3354	(26)
COMP	1.	MONOCULTURE	4667.0000	359.0000	209.3267	43817.6667	(13)
COMP	2.	MIXTURE	5417.0000	416.6923	189.1289	35769.7308	(13)
CUL	4.	70M009002	36401.0000	282.1783	194.2865	37747.2414	(129)
SPAC	1.	204 PLANTS M	2350.0000	117.5000	53.9488	2910.4737	(20)
COMP	2.	MIXTURE	2350.0000	117.5000	53.9488	2910.4737	(20)
SPAC	2.	3 CM SPACING	3173.0000	144.2273	61.6271	3797.8983	(22)
COMP	2.	MIXTURE	3173.0000	144.2273	61.6271	3797.8983	(22)

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3	9 CM SPACING	4556.0000	227.8000	122.2468	14944.2737	(20)
COMP	2.	MIXTURE	4556.0000	227.8000	122.2468	14944.2737	(20)
SPAC	4.	44 PLANTS M	4430.0000	260.5882	117.3601	13773.3824	(17)
COMP	2	MIXTURE	4430.0000	260.5882	117.3601	13773.3824	(17)
SPAC	5	28 PLANTS M	7105.0000	373.9474	115.1875	13268.1637	(19)
COMP	2	MIXTURE	7105.0000	373.9474	115.1875	13268.1637	19)
SPAC	6	17 PLANTS M	8782.0000	439.1000	174.4199	30422.3053	(20)
COMP	2.	MIXTURE	8782.0000	439.1000	174.4199	30422.3053	(20)
SPAC	7	10 PLANTS M	6005.0000	545.9091	304.9133	92972.0909	(11)
COMP	2.	MIXTURE	6005.0000	545.9091	304.9133	92972.0909	(11)
CUL	5	NORQUAY	40446.0000	278.9379	281.7068	79358.7392	(145)
SPAC	1	204 PLANTS M	4092.0000	116.9143	76.7028	5883.3160	(35)
COMP	1	MONOCULTURE	1995.0000	124.6875	48.7644	2377.9625	(16)
COMP	2.	MIXTURE	2097.0000	110.3684	95.0387	9032.3567	(19)
SPAC	2.	3 CM SPACING	3212.0000	152.9524	88.3269	7801.6476	(21)
COMP	1.	MONOCULTURE	1792.0000	199.1111	107.0764	11465.3611	(9)
COMP	2.	MIXTURE	1420.0000	118.3333	52.8744	2795.6970	(12)
SPAC	3.	9 CM SPACING	3727.0000	162.0435	60.9929	3720.1344	(23)
COMP	1	MONOCULTURE	1534.0000	153.4000	67.5906	4568.4889	(10)
COMP	2.	MIXTURE	2193.0000	168.6923	57.3038	3283.7308	(13)
SPAC	4.	44 PLANTS M	8417.0000	311.7407	165.3578	27343.1994	(27)
COMP	1	MONOCULTURE	4062.0000	369.2727	208.5584	43496.6182	(11)
COMP	2.	MIXTURE	4355.0000	272.1875	119.5872	14301.0958	(16)
SPAC	5.	28 PLANTS M	3788.0000	315.6667	174.0639	30298.2424	(12)
COMP	1.	MONOCULTURE	3788.0000	315.6667	174.0639	30298.2424	(12)

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	3730.0000	466.2500	409.7022	167855.9286	(8)
COMP	1.	MONOCULTURE	3730.0000	466.2500	409.7022	167855.9286	(8)
SPAC	7.	10 PLANTS M	13480.0000	709.4737	431.8153	186464.4854	(19)
COMP	1.	MONOCULTURE	5525.0000	613.8889	339.6986	115395.1111	(9)
COMP	2.	MIXTURE	7955.0000	795.5000	502.8874	252896.2778	(10)
CUL	6.	70M009002	47021.0000	370.2441	359.0327	128904.4658	(127)
SPAC	1.	204 PLANTS M	2010.0000	111.6667	49.5450	2454.7059	(18)
COMP	2.	MIXTURE	2010.0000	111.6667	49.5450	2454.7059	(18)
SPAC	2.	3 CM SPACING	2680.0000	121.8182	55.5094	3081.2987	(22)
COMP	2.	MIXTURE	2680.0000	121.8182	55.5094	3081.2987	(22)
SPAC	3.	9 CM SPACING	2555.0000	159.6875	78.5729	6173.6958	(16)
COMP	2.	MIXTURE	2555.0000	159.6875	78.5729	6173.6958	(16)
SPAC	4.	44 PLANTS M	4087.0000	340.5833	170.7302	29148.8106	(12)
COMP	2.	MIXTURE	4087.0000	340.5833	170.7302	29148.8106	(12)
SPAC	5.	28 PLANTS M	6497.0000	360.9444	197.5260	39016.5261	(18)
COMP	2.	MIXTURE	6497.0000	360.9444	197.5260	39016.5261	(18)
SPAC	6.	17 PLANTS M	13111.0000	624.3333	428.7459	183823.0333	(21)
COMP	2.	MIXTURE	13111.0000	624.3333	428.7459	183823.0333	(21)
SPAC	7.	10 PLANTS M	16081.0000	804.0500	396.0516	156856.8921	(20)
COMP	2.	MIXTURE	16081.0000	804.0500	396.0516	156856.8921	(20)
CUL	7.	NORQUAY	29825.0000	458.8462	318.8438	101661.3822	(65)
SPAC	1.	204 PLANTS M	1116.0000	139.5000	66.5260	4425.7143	(8)
COMP	2.	MIXTURE	1116.0000	139.5000	66.5260	4425.7143	(8)
SPAC	2.	3 CM SPACING	2334.0000	212.1818	126.1728	15919.5636	(11)
COMP	1.	MONOCULTURE	1477.0000	246.1667	157.9651	24952.9667	(6)

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2	MIXTURE	857.0000	171.4000	69.2553	4796.3000	(5)
SPAC	3	9 CM SPACING	1731.0000	288.5000	152.7662	23337.5000	(6)
COMP	1	MONOCULTURE	1731.0000	288.5000	152.7662	23337.5000	(6)
SPAC	4	44 PLANTS M	2310.0000	385.0000	156.8770	24610.4000	(6)
COMP	1	MONOCULTURE	2310.0000	385.0000	156.8770	24610.4000	(6)
SPAC	5.	28 PLANTS M	4672.0000	667.4286	140.1914	19653.6190	(7)
COMP	2	MIXTURE	4672.0000	667.4286	140.1914	19653.6190	(7)
SPAC	6	17 PLANTS M	8451.0000	563.4000	232.6425	54122.5429	(15)
COMP	2	MIXTURE	8451.0000	563.4000	232.6425	54122.5429	(15)
SPAC	7	10 PLANTS M	9211.0000	767.5833	415.2190	172406.8106	(12)
COMP	1	MONOCULTURE	5107.0000	851.1667	473.4175	224124.1667	(6)
COMP	2	MIXTURE	4104.0000	684.0000	372.0269	138404.0000	(6)
CUL	8	NB701	79260.0000	437.9006	371.4790	137996.6678	(181)
SPAC	1.	204 PLANTS M	4447.0000	177.8800	51.9898	2702.9433	(25)
COMP	2	MIXTURE	4447.0000	177.8800	51.9898	2702.9433	(25)
SPAC	2	3 CM SPACING	5429.0000	169.6563	71.8595	5163.7813	(32)
COMP	2.	MIXTURE	5429.0000	169.6563	71.8595	5163.7813	(32)
SPAC	3.	9 CM SPACING	6063.0000	252.6250	100.6664	10133.7228	(24)
COMP	2	MIXTURE	6063.0000	252.6250	100.6664	10133.7228	(24)
SPAC	4.	44 PLANTS M	10537.0000	351.2333	133.2585	17757.8402	(30)
COMP	2	MIXTURE	10537.0000	351.2333	133.2585	17757.8402	(30)
SPAC	5.	28 PLANTS M	11149.0000	619.3889	217.6087	47353.5458	(18)
COMP	2	MIXTURE	11149.0000	619.3889	217.6087	47353.5458	(18)
SPAC	6	17 PLANTS M	17191.0000	747.4348	378.1605	143005.3478	(23)
COMP	2	MIXTURE	17191.0000	747.4348	378.1605	143005.3478	(23)

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	24444.0000	842.8966	511.3037	261431.4532	(29)
COMP	2.	MIXTURE	24444.0000	842.8966	511.3037	261431.4532	(29)

TOTAL CASES = 1080
MISSING CASES = 48 OR 4.4 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE EL EXTRUSION LENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			61344.0000	58.5344	12.5076	156 4458	(1048)
CUL	2.	GLENLEA	13120 0000	72.0879	9 1539	83 7933	(182)
SPAC	1.	204 PLANTS M	1762 0000	73 4167	9 9035	98.0797	(24)
COMP	1.	MONOCULTURE	817 0000	74.2727	7 9132	62 6182	(11)
COMP	2.	MIXTURE	945.0000	72 6923	11 6002	134.5641	(13)
SPAC	2.	3 CM SPACING	2582.0000	73 7714	8.0040	64.0639	(35)
COMP	1.	MONOCULTURE	1016.0000	72.5714	11.6137	134.8791	(14)
COMP	2.	MIXTURE	1566.0000	74.5714	4.4223	19.5571	(21)
SPAC	3.	9 CM SPACING	2534.0000	72.4000	10.9442	119.7765	(35)
COMP	1.	MONOCULTURE	943.0000	72.5385	13.6114	185.2692	(13)
COMP	2.	MIXTURE	1591.0000	72.3182	9.3828	88.0368	(22)
SPAC	4.	44 PLANTS M	2084.0000	71.8621	10.3120	106.3374	(29)
COMP	1.	MONOCULTURE	967.0000	74.3846	10.5794	111.9231	(13)
COMP	2.	MIXTURE	1117.0000	69.8125	9.9480	98.9625	(16)
SPAC	5.	28 PLANTS M	1416.0000	70.8000	7.5016	56.2737	(20)
COMP	1.	MONOCULTURE	1066.0000	71.0667	7.2651	52.7810	(15)
COMP	2.	MIXTURE	350.0000	70.0000	9.0277	81.5000	(5)
SPAC	6.	17 PLANTS M	1424.0000	71.2000	6.7715	45.8526	(20)
COMP	1.	MONOCULTURE	939.0000	72.2308	6.7842	46.0256	(13)
COMP	2.	MIXTURE	485.0000	69.2857	6.8243	46.5714	(7)
SPAC	7.	10 PLANTS M	1318.0000	69.3684	8.8394	78.1345	(19)
COMP	1.	MONOCULTURE	567.0000	70.8750	8.9513	80.1250	(8)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	751.0000	68.2727	9.0232	81.4182	(11)
CUL	3.	PARK	11307.0000	54.6232	6.8587	47.0418	(207)
SPAC	1.	204 PLANTS M	1444.0000	57.7600	4.8501	23.5233	(25)
COMP	1.	MONOCULTURE	351.0000	58.5000	3.7283	13.9000	(6)
COMP	2.	MIXTURE	1093.0000	57.5263	5.2214	27.2632	(19)
SPAC	2.	3 CM SPACING	2257.0000	55.0488	7.6680	58.7976	(41)
COMP	1.	MONOCULTURE	789.0000	56.3571	7.6219	58.0934	(14)
COMP	2.	MIXTURE	1468.0000	54.3704	7.7467	60.0114	(27)
SPAC	3.	9 CM SPACING	1852.0000	57.8750	6.8096	46.3710	(32)
COMP	1.	MONOCULTURE	710.0000	59.1667	5.0422	25.4242	(12)
COMP	2.	MIXTURE	1142.0000	57.1000	7.6976	59.2526	(20)
SPAC	4.	44 PLANTS M	1509.0000	53.8929	4.7946	22.9881	(28)
COMP	1.	MONOCULTURE	605.0000	55.0000	5.0794	25.8000	(11)
COMP	2.	MIXTURE	904.0000	53.1765	4.6130	21.2794	(17)
SPAC	5.	28 PLANTS M	1554.0000	53.5862	5.2612	27.6798	(29)
COMP	1.	MONOCULTURE	809.0000	53.9333	5.4572	29.7810	(15)
COMP	2.	MIXTURE	745.0000	53.2143	5.2209	27.2582	(14)
SPAC	6.	17 PLANTS M	1345.0000	51.7308	8.2828	68.6046	(26)
COMP	1.	MONOCULTURE	660.0000	50.7692	8.4474	71.3590	(13)
COMP	2.	MIXTURE	685.0000	52.6923	8.3405	69.5641	(13)
SPAC	7.	10 PLANTS M	1346.0000	51.7692	6.8077	46.3446	(26)
COMP	1.	MONOCULTURE	673.0000	51.7692	8.3582	69.8590	(13)
COMP	2.	MIXTURE	673.0000	51.7692	5.1665	26.6923	(13)
CUL	4.	70M009002	8027.0000	61.2748	9.0639	82.1547	(131)
SPAC	1.	204 PLANTS M	1213.0000	60.6500	9.3599	87.6079	(20)
COMP	2.	MIXTURE	1213.0000	60.6500	9.3599	87.6079	(20)
SPAC	2.	3 CM SPACING	1523.0000	66.2174	8.0451	64.7233	(23)
COMP	2.	MIXTURE	1523.0000	66.2174	8.0451	64.7233	(23)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	1228.0000	61.4000	11.8117	139.5158	(20)
COMP	2.	MIXTURE	1228.0000	61.4000	11.8117	139.5158	(20)
SPAC	4.	44 PLANTS M	1063.0000	62 5294	11.0120	121.2647	(17)
COMP	2.	MIXTURE	1063.0000	62.5294	11.0120	121.2647	(17)
SPAC	5.	28 PLANTS M	1186.0000	62.4211	5.9378	35.2573	(19)
COMP	2.	MIXTURE	1186.0000	62.4211	5.9378	35.2573	(19)
SPAC	6.	17 PLANTS M	1171.0000	58.5500	5.6613	32.0500	(20)
COMP	2.	MIXTURE	1171.0000	58.5500	5.6613	32.0500	(20)
SPAC	7.	10 PLANTS M	643.0000	53.5833	5.0174	25.1742	(12)
COMP	2.	MIXTURE	643.0000	53.5833	5.0174	25.1742	(12)
CUL	5.	NORQUAY	6411.0000	44.2138	8.9978	80.9609	(145)
SPAC	1.	204 PLANTS M	1554.0000	44.4000	7.9786	63.6588	(35)
COMP	1.	MONOCULTURE	704.0000	44.0000	4.7749	22.8000	(16)
COMP	2.	MIXTURE	850.0000	44.7368	10.0490	100.9825	(19)
SPAC	2.	3 CM SPACING	1031.0000	46.8636	11.0982	123.1710	(22)
COMP	1.	MONOCULTURE	488.0000	48.8000	10.9524	119.9556	(10)
COMP	2.	MIXTURE	543.0000	45.2500	11.4346	130.7500	(12)
SPAC	3.	9 CM SPACING	1022.0000	44.4348	11.2162	125.8024	(23)
COMP	1.	MONOCULTURE	395.0000	39.5000	7.0277	49.3889	(10)
COMP	2.	MIXTURE	627.0000	48.2308	12.5576	157.6923	(13)
SPAC	4.	44 PLANTS M	1191.0000	45.8077	9.3167	86.8015	(26)
COMP	1.	MONOCULTURE	422.0000	42 2000	5.4732	29.9556	(10)
COMP	2.	MIXTURE	769.0000	48.0625	10.6111	112.5958	(16)
SPAC	5.	28 PLANTS M	486.0000	40.5000	4.7001	22.0909	(12)
COMP	1.	MONOCULTURE	486.0000	40.5000	4 7001	22.0909	(12)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	306.0000	38.2500	6.5192	42.5000	(8)
COMP	1.	MONOCULTURE	306.0000	38.2500	6.5192	42.5000	(8)
SPAC	7.	10 PLANTS M	821.0000	43.2105	6.3995	40.9532	(19)
COMP	1.	MONOCULTURE	375.0000	41.6667	2.9580	8.7500	(9)
COMP	2.	MIXTURE	446.0000	44.6000	8.3427	69.6000	(10)
CUL	6.	70M009002	6785.0000	51.7939	6.2286	38.7957	(131)
SPAC	1.	204 PLANTS M	975.0000	54.1667	8.2194	67.5588	(18)
COMP	2.	MIXTURE	975.0000	54.1667	8.2194	67.5588	(18)
SPAC	2.	3 CM SPACING	1135.0000	51.5909	7.1757	51.4913	(22)
COMP	2.	MIXTURE	1135.0000	51.5909	7.1757	51.4913	(22)
SPAC	3.	9 CM SPACING	959.0000	53.2778	4.7379	22.4477	(18)
COMP	2.	MIXTURE	959.0000	53.2778	4.7379	22.4477	(18)
SPAC	4.	44 PLANTS M	685.0000	57.0833	4.2310	17.9015	(12)
COMP	2.	MIXTURE	685.0000	57.0833	4.2310	17.9015	(12)
SPAC	5.	28 PLANTS M	869.0000	48.2778	4.1841	17.5065	(18)
COMP	2.	MIXTURE	869.0000	48.2778	4.1841	17.5065	(18)
SPAC	6.	17 PLANTS M	1094.0000	49.7273	5.6331	31.7316	(22)
COMP	2.	MIXTURE	1094.0000	49.7273	5.6331	31.7316	(22)
SPAC	7.	10 PLANTS M	1068.0000	50.8571	4.7884	22.9286	(21)
COMP	2.	MIXTURE	1068.0000	50.8571	4.7884	22.9286	(21)
CUL	7.	NORQUAY	3418.0000	49.5362	5.7512	33.0759	(69)
SPAC	1.	204 PLANTS M	462.0000	51.3333	6.0415	36.5000	(9)
COMP	2.	MIXTURE	462.0000	51.3333	6.0415	36.5000	(9)
SPAC	2.	3 CM SPACING	612.0000	51.0000	4.4721	20.0000	(12)
COMP	1.	MONOCULTURE	311.0000	51.8333	3.9200	15.3667	(6)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	301.0000	50.1667	5.1929	26.9667	(6)
SPAC	3.	9 CM SPACING	288.0000	48.0000	3.6332	13.2000	(6)
COMP	1.	MONOCULTURE	288.0000	48.0000	3.6332	13.2000	(6)
SPAC	4.	44 PLANTS M	359.0000	51.2857	7.1348	50.9048	(7)
COMP	1.	MONOCULTURE	359.0000	51.2857	7.1348	50.9048	(7)
SPAC	5.	28 PLANTS M	411.0000	51.3750	5.0125	25.1250	(8)
COMP	2.	MIXTURE	411.0000	51.3750	5.0125	25.1250	(8)
SPAC	6.	17 PLANTS M	733.0000	48.8667	5.8416	34.1238	(15)
COMP	2.	MIXTURE	733.0000	48.8667	5.8416	34.1238	(15)
SPAC	7.	10 PLANTS M	553.0000	46.0833	6.3598	40.4470	(12)
COMP	1.	MONOCULTURE	278.0000	46.3333	6.7725	45.8667	(6)
COMP	2.	MIXTURE	275.0000	45.8333	6.5549	42.9667	(6)
CUL	8.	NB701	12276.0000	67.0820	9.6879	93.8559	(183)
SPAC	1.	204 PLANTS M	1849.0000	73.9600	7.6184	58.0400	(25)
COMP	2.	MIXTURE	1849.0000	73.9600	7.6184	58.0400	(25)
SPAC	2.	3 CM SPACING	2323.0000	72.5938	8.5755	73.5393	(32)
COMP	2.	MIXTURE	2323.0000	72.5938	8.5755	73.5393	(32)
SPAC	3.	9 CM SPACING	1661.0000	69.2083	8.2566	68.1721	(24)
COMP	2.	MIXTURE	1661.0000	69.2083	8.2566	68.1721	(24)
SPAC	4.	44 PLANTS M	2064.0000	66.5806	12.8369	164.7849	(31)
COMP	2.	MIXTURE	2064.0000	66.5806	12.8369	164.7849	(31)
SPAC	5.	28 PLANTS M	1184.0000	65.7778	5.9858	35.8301	(18)
COMP	2.	MIXTURE	1184.0000	65.7778	5.9858	35.8301	(18)
SPAC	6.	17 PLANTS M	1481.0000	61.7083	5.8717	34.4764	(24)
COMP	2.	MIXTURE	1481.0000	61.7083	5.8717	34.4764	(24)

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CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1714.0000	59.1034	4.8355	23.3818	(29)
COMP	2.	MIXTURE	1714.0000	59.1034	4.8355	23.3818	(29)

TOTAL CASES = 1080
MISSING CASES = 32 OR 3.0 PCT.

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FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE KH NUMBER OF KERNELS PER HEAD
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			48596.7601	47.2272	30.0464	902.7861	(1029)
CUL	2	GLENLEA	7681.5181	43.1546	17 4313	303.8510	(178)
SPAC	1	204 PLANTS M	821.8777	35 7338	10 9786	120.5301	(23)
COMP	1	MONOCULTURE	380.3167	34 5742	14.6860	215.6784	(11
COMP	2.	MIXTURE	441.5611	36 7968	6.5124	42.4118	(12)
SPAC	2.	3 CM SPACING	1200.7261	35.3155	7.8346	61.3806	(34)
COMP	1	MONOCULTURE	409.7738	31.5211	7 8535	61.6781	(13)
COMP	2.	MIXTURE	790.9523	37 6644	7.0085	49.1194	(21)
SPAC	3	9 CM SPACING	1301.4760	37 1850	9.2065	84.7600	(35)
COMP	1.	MONOCULTURE	423 0904	32 5454	5.9363	35.2402	(13)
COMP	2	MIXTURE	878.3856	39.9266	9.7925	95.8934	(22)
SPAC	4.	44 PLANTS M	1173.9508	41 9268	8.6402	78.1490	(28)
COMP	1.	MONOCULTURE	518.1222	39.8556	3.0789	9.4798	(13)
COMP	2.	MIXTURE	655.8287	43.7219	11.6256	135.1542	(15)
SPAC	5.	28 PLANTS M	915.8982	45.7949	8.3218	69.2518	(20)
COMP	1.	MONOCULTURE	681.8582	45.4572	8.8754	78.7724	(15)
COMP	2	MIXTURE	234.0400	46.8080	7 1786	51.5324	(5)
SPAC	6	17 PLANTS M	1078.4954	56 7625	18.6603	348.2073	(19)
COMP	1	MONOCULTURE	587.3883	48.9490	12 1367	147 2990	(12)
COMP	2	MIXTURE	491.1071	70 1582	21.0505	443.1220	(7)
SPAC	7	10 PLANTS M	1189.0937	62 5839	34.1998	1169.6233	(19)
COMP	1	MONOCULTURE	352.3312	44.0414	14.3582	206.1591	(8)

CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	836.7625	76.0693	38.5475	1485.9089	(11)
CUL	3.	PARK	8571.1043	41.6073	15.4078	237.3998	(206)
SPAC	1.	204 PLANTS M	733.3737	29.3349	8.5596	73.2675	(25)
COMP	1.	MONOCULTURE	162.9167	27.1528	5.7495	33.0567	(6)
COMP	2.	MIXTURE	570.4570	30.0241	9.2962	86.4190	(19)
SPAC	2.	3 CM SPACING	1189.7334	29.7433	8.5502	73.1056	(40)
COMP	1.	MONOCULTURE	415.9107	31.9931	7.3812	54.4827	(13)
COMP	2.	MIXTURE	773.8227	28.6601	8.9868	80.7633	(27)
SPAC	3.	9 CM SPACING	1286.9626	40.2176	12.2992	151.2696	(32)
COMP	1.	MONOCULTURE	471.2162	39.2680	6.2528	39.0971	(12)
COMP	2.	MIXTURE	815.7464	40.7873	14.9420	223.2620	(20)
SPAC	4.	44 PLANTS M	1191.1323	42.5404	7.8294	61.2997	(28)
COMP	1.	MONOCULTURE	464.2373	42.2034	6.1761	38 1441	(11)
COMP	2.	MIXTURE	726.8951	42.7585	8.9149	79.4746	(17)
SPAC	5.	28 PLANTS M	1380.8783	47.6165	10.6079	112.5281	(29)
COMP	1.	MONOCULTURE	710.8634	47.3909	10.4827	109.8868	(15)
COMP	2.	MIXTURE	670.0149	47.8582	11.1314	123.9070	(14)
SPAC	6.	17 PLANTS M	1362.5421	52.4055	16.0990	259.1765	(26)
COMP	1.	MONOCULTURE	679.5418	52.2724	10.8000	116.6404	(13)
COMP	2.	MIXTURE	683.0003	52.5385	20.5736	423.2722	(13)
SPAC	7.	10 PLANTS M	1426.4820	54.8647	19.9526	398.1057	(26)
COMP	1.	MONOCULTURE	771.1532	59.3195	10.9728	120.4029	(13)
COMP	2.	MIXTURE	655.3288	50.4099	25.8067	665.9864	(13)
CUL	4.	70MO09002	5195.4514	40.2748	15.7544	248.2016	(129)
SPAC	1.	204 PLANTS M	548.1642	27.4082	9.4147	88.6365	(20)
COMP	2.	MIXTURE	548.1642	27 4082	9.4147	88.6365	(20)
SPAC	2.	3 CM SPACING	793.1975	36.0544	9.8295	96.6188	(22)
COMP	2.	MIXTURE	793.1975	36 0544	9.8295	96.6188	(22)

CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3	9 CM SPACING	724.7551	36.2378	13.9306	194 0624	(20)
COMP	2	MIXTURE	724 7551	36.2378	13 9306	194 0624	(20)
SPAC	4.	44 PLANTS M	779.3892	45.8464	21 5679	465 1732	(17)
COMP	2.	MIXTURE	779.3892	45 8464	21.5679	465 1732	(17)
SPAC	5	28 PLANTS M	886 2067	46 6425	10.8530	117 7887	(19)
COMP	2	MIXTURE	886 2067	46.6425	10.8530	117 7887	(19.
SPAC	6	17 PLANTS M	1003 8302	50 1915	16 8506	355 3462	(20)
COMP	2	MIXTURE	1003.8302	50.1915	16 8506	355 3462	(20)
SPAC	7	10 PLANTS M	459.9085	41 8099	6 5751	73 5329	(11
COMP	2	MIXTURE	459.9085	41 8099	6 5751	73 5329	(11)
CUL	5	NOROUAY	5843.3641	40 5789	19 9821	399 2831	(144)
SPAC	1	204 PLANTS M	997 0690	28 4877	8.3975	70.5184	(35)
COMP	1	MONOCULTURE	497 2666	31 0792	6 6646	44 4163	(16)
COMP	2	MIXTURE	499.8023	26.3054	9 2299	85.1912	(19)
SPAC	2.	3 CM SPACING	662.3023	33.1151	11 4121	130.2352	(20)
COMP	1.	MONOCULTURE	333 4785	37.0532	11.1301	123 8791	(9)
COMP	2	MIXTURE	328.8238	29.8931	11.0890	122.9664	(11)
SPAC	3.	9 CM SPACING	828.3916	36.0170	8.3719	70 0890	(23)
COMP	1	MONOCULTURE	365.8250	36.5825	7.6952	59.2155	(10)
COMP	2	MIXTURE	462.5666	35.5820	9.1440	83 6135	(13)
SPAC	4	44 PLANTS M	1096 7240	40 6194	14 0709	197.9900	(27)
COMP	1	MONOCULTURE	481 1217	43.7383	14 9372	223 1211	(11)
COMP	2	MIXTURE	615.6023	38 4751	13 5054	182.3972	(16)
SPAC	5.	28 PLANTS M	560 1953	46.6829	13.0792	171.0642	(12)
COMP	1.	MONOCULTURE	560.1953	46 6829	13.0792	171.0642	(12)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	413.3506	51.6688	13.4005	179.5738	(8)
COMP	1.	MONOCULTURE	413.3506	51.6688	13.4005	179.5738	(8)
SPAC	7.	10 PLANTS M	1285.3313	67.6490	33.6098	1129.6200	(19)
COMP	1.	MONOCULTURE	499.5719	55.5080	10.3855	107.8584	(9)
COMP	2.	MIXTURE	785.7594	78.5759	43.3970	1883.2974	(10)
CUL	6.	70MOO9002	6878.4120	54.1607	37.5907	1413.0602	(127)
SPAC	1.	204 PLANTS M	597.2833	33.1824	10.1565	103.1545	(18)
COMP	2.	MIXTURE	597.2833	33.1824	10.1565	103.1545	(18)
SPAC	2.	3 CM SPACING	700.2285	31.8286	12.2808	150.8180	(22)
COMP	2.	MIXTURE	700.2285	31.8286	12.2808	150.8180	(22)
SPAC	3.	9 CM SPACING	645.1880	40.3243	16.8801	284.9387	(16)
COMP	2.	MIXTURE	645.1880	40.3243	16 8801	284.9387	(16)
SPAC	4.	44 PLANTS M	606.5974	50.5498	10.6921	114.3216	(12)
COMP	2.	MIXTURE	606.5974	50.5498	10.6921	114.3216	(12)
SPAC	5.	28 PLANTS M	1071.9321	59.5518	26.4825	701.3251	(18)
COMP	2.	MIXTURE	1071.9321	59.5518	26.4825	701.3251	(18)
SPAC	6.	17 PLANTS M	1469.1852	69.9612	44.2795	1960.6712	(21)
COMP	2.	MIXTURE	1469.1852	69.9612	44.2795	1960.6712	(21)
SPAC	7.	10 PLANTS M	1787.9973	89.3999	57.9211	3354.8508	(20)
COMP	2.	MIXTURE	1787.9973	89.3999	57.9211	3354.8508	(20)
CUL	7.	NORQUAY	3758.2950	57.8199	40.0526	1604.2071	(65)
SPAC	1.	204 PLANTS M	246.0833	30.7604	8.3498	69 7191	(8)
COMP	2.	MIXTURE	246.0833	30.7604	8.3498	69.7191	(8)
SPAC	2.	3 CM SPACING	436.5273	39.6843	12.1537	147.7128	(11)
COMP	1.	MONOCULTURE	276.7083	46.1181	11.9590	143.0170	(6)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	159.8190	31.9638	7 3426	53.9133	(5)
SPAC	3	9 CM SPACING	330.5278	55 0880	15.6009	243.3890	(6)
COMP	1	MONOCULTURE	330 5278	55 0880	15.6009	243 3890	(6)
SPAC	4	44 PLANTS M	328 4269	54 7378	15.2799	233 4749	(6)
COMP	1	MONOCULTURE	328 4269	54 7378	15.2799	233 4749	(6
SPAC	5	28 PLANTS M	398 9833	56 9976	17 3478	300 9469	(7)
COMP	2	MIXTURE	398 9833	56.9976	17 3478	300 9469	(7)
SPAC	6	17 PLANTS M	1058.8564	70 5904	65 5550	4297 4613	(15
COMP	2	MIXTURE	1058 8564	70.5904	65.5550	4297 4613	(15)
SPAC	7	10 PLANTS M	958 8899	79 9075	40 9732	1678 8056	(12)
COMP	1	MONOCULTURE	563.5500	93 9250	46.9734	2206 4971	(6)
COMP	2.	MIXTURE	395 3399	65 8900	31.8637	1015 2982	(6)
CUL	8	NB701	10668.6153	59.2701	46 9441	2203.7462	(180)
SPAC	1	204 PLANTS M	1089.0999	43.5640	7 1617	51 2901	(25)
COMP	2	MIXTURE	1089.0999	43 5640	7.1617	51.2901	(25)
SPAC	2	3 CM SPACING	1291.4118	41.6584	8.5718	73 4757	(31)
COMP	2	MIXTURE	1291.4118	41.6584	8.5718	73 4757	(31)
SPAC	3	9 CM SPACING	1105.2297	46 0512	7.8976	62.3725	(24)
COMP	2.	MIXTURE	1105.2297	46.0512	7.8976	62.3725	(24)
SPAC	4.	44 PLANTS M	1593.7350	53 1245	17 5119	306.6650	(30)
COMP	2.	MIXTURE	1593.7350	53 1245	17.5119	306 6650	(30)
SPAC	5	28 PLANTS M	1026 4320	57.0240	14 1636	200.6068	(18)
COMP	2	MIXTURE	1026 4320	57.0240	14 1636	200.6068	(18)
SPAC	6.	17 PLANTS M	1700 7707	73 9466	35.8588	1285.8555	(23)
COMP	2.	MIXTURE	1700 7707	73.9466	35.8588	1285.8555	(23)

CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	2861.9361	98.6875	99.6057	9921.2922	(29)
COMP	2.	MIXTURE	2861.9361	98.6875	99.6057	9921.2922	(29)

TOTAL CASES = 1080
MISSING CASES = 51 OR 4.7 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE YH SEED YIELD PER HEAD G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1968.0993	1.9071	1.0326	1 0662	(1032)
CUL	2.	GLENLEA	385.0532	2.1392	0.8522	0 7262	(180)
SPAC	1.	204 PLANTS M	41.8094	1.8178	0.4814	0 2317	(23)
COMP	1.	MONOCULTURE	18.9426	1.7221	0.5848	0 3420	(11)
COMP	2.	MIXTURE	22.8669	1.9056	0.3673	0 1349	(12)
SPAC	2.	3 CM SPACING	60.8771	1.7905	0.4431	0 1963	(34)
COMP	1.	MONOCULTURE	20.6356	1.5874	0.4664	0.2175	(13)
COMP	2.	MIXTURE	40.2415	1.9163	0.3872	0 1499	(21)
SPAC	3.	9 CM SPACING	65.6227	1.8749	0.5290	0 2799	(35)
COMP	1.	MONOCULTURE	20.5213	1.5786	0.4082	0.1666	(13)
COMP	2.	MIXTURE	45.1013	2.0501	0.5210	0.2714	(22)
SPAC	4.	44 PLANTS M	60.3123	2.0797	0.5411	0.2928	(29)
COMP	1.	MONOCULTURE	25.6163	1.9705	0.2055	0.0422	(13)
COMP	2.	MIXTURE	34.6960	2.1685	0.7028	0 4940	(16)
SPAC	5.	28 PLANTS M	43.8273	2.1914	0.4073	0.1659	(20)
COMP	1.	MONOCULTURE	32.5059	2.1671	0.4190	0 1756	(15)
COMP	2.	MIXTURE	11.3214	2.2643	0.4056	0 1645	(5)
SPAC	6.	17 PLANTS M	54.5602	2.7280	0.9471	0.8971	(20)
COMP	1.	MONOCULTURE	31.4904	2.4223	0.6262	0 3921	(13)
COMP	2.	MIXTURE	23.0698	3.2957	1.2158	1.4783	(7)
SPAC	7.	10 PLANTS M	58.0442	3.0550	1.6421	2 6964	(19)
COMP	1.	MONOCULTURE	17.8886	2.2361	0.7544	0 5691	(8)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	40.1566	3.6505	1.8784	3.5285	(11)
CUL	3.	PARK	304.1494	1.4765	0.5195	0.2699	(206)
SPAC	1.	204 PLANTS M	27.4426	1.0977	0.3643	0.1328	(25)
COMP	1.	MONOCULTURE	5.8333	0.9722	0.2362	0.0558	(6)
COMP	2.	MIXTURE	21.6093	1.1373	0.3932	0.1546	(19)
SPAC	2.	3 CM SPACING	43.6309	1.0908	0.3654	0.1335	(40)
COMP	1.	MONOCULTURE	15.4930	1.1918	0.3392	0.1151	(13)
COMP	2.	MIXTURE	28.1378	1.0421	0.3737	0.1396	(27)
SPAC	3.	9 CM SPACING	45.4758	1.4211	0.4347	0.1890	(32)
COMP	1.	MONOCULTURE	16.3301	1.3608	0.2223	0.0494	(12)
COMP	2.	MIXTURE	29.1456	1.4573	0.5254	0.2761	(20)
SPAC	4.	44 PLANTS M	43.9641	1.5701	0.3526	0.1243	(28)
COMP	1.	MONOCULTURE	16.3164	1.4833	0.3848	0.1481	(11)
COMP	2.	MIXTURE	27.6478	1.6263	0.3297	0.1087	(17)
SPAC	5.	28 PLANTS M	48.4452	1.6705	0.3996	0.1597	(29)
COMP	1.	MONOCULTURE	24.2539	1.6169	0.4481	0.2008	(15)
COMP	2.	MIXTURE	24.1914	1.7280	0.3476	0.1208	(14)
SPAC	6.	17 PLANTS M	46.7801	1.7992	0.5057	0.2557	(26)
COMP	1.	MONOCULTURE	23.9760	1.8443	0.3773	0.1423	(13)
COMP	2.	MIXTURE	22.8041	1.7542	0.6213	0.3860	(13)
SPAC	7.	10 PLANTS M	48.4106	1.8619	0.6104	0.3725	(26)
COMP	1.	MONOCULTURE	25.6712	1.9747	0.3194	0.1020	(13)
COMP	2.	MIXTURE	22.7394	1.7492	0.8041	0.6465	(13)
CUL	4.	70M009002	184 8916	1.4333	0.5446	0.2965	(129)
SPAC	1.	204 PLANTS M	19.3851	0.9693	0.3434	0.1179	(20)
COMP	2.	MIXTURE	19.3851	0.9693	0.3434	0.1179	(20)
SPAC	2.	3 CM SPACING	29.1667	1.3258	0.3877	0.1503	(22)
COMP	2	MIXTURE	29.1667	1.3258	0.3877	0.1503	(22)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3	9 CM SPACING	26.1172	1.3059	0.4493	0.2018	(20)
COMP	2	MIXTURE	26 1172	1 3059	0.4493	0 2018	(20)
SPAC	4	44 PLANTS M	25.3329	1.4902	0 3240	0 1050	(17)
COMP	2	MIXTURE	25 3329	1.4902	0.3240	0 1050	(17)
SPAC	5.	28 PLANTS M	32.6414	1.7180	0.3865	0.1494	(19)
COMP	2	MIXTURE	32 6414	1.7180	0.3865	0 1494	(19)
SPAC	6	17 PLANTS M	36.3441	1.8172	0.8051	0.6482	(20)
COMP	2	MIXTURE	36.3441	1.8172	0.8051	0.6482	(20)
SPAC	7	10 PLANTS M	15 9043	1.4458	0.5110	0 2611	(11)
COMP	2	MIXTURE	15 9043	1.4458	0 5110	0.2611	(11)
CUL	5	NOROUAY	255 0081	1.7709	0.8036	0 6457	(144)
SPAC	1	204 PLANTS M	45 4330	1.2981	0.3946	0 1557	(35)
COMP	1	MONOCULTURE	22.9813	1.4363	0.3132	0.0981	(16)
COMP	2	MIXTURE	22 4517	1.1817	0.4255	0 1811	(19)
SPAC	2.	3 CM SPACING	30 0314	1.5016	0 4878	0.2379	(20)
COMP	1	MONOCULTURE	15.3437	1.7049	0 4866	0 2368	(9)
COMP	2.	MIXTURE	14.6877	1.3352	0.4415	0.1950	(11)
SPAC	3	9 CM SPACING	36.6389	1.5930	0.3577	0.1280	(23)
COMP	1	MONOCULTURE	16.6607	1.6661	0.3223	0.1039	(10)
COMP	2	MIXTURE	19.9783	1.5368	0.3858	0 1488	(13)
SPAC	4.	44 PLANTS M	46 0092	1.7040	0.5187	0.2690	(27)
COMP	1	MONOCULTURE	19 8947	1.8086	0.4112	0 1691	(11)
COMP	2	MIXTURE	26 1145	1.6322	0.5831	0.3401	(16)
SPAC	5.	28 PLANTS M	24 3208	2.0267	0.4921	0.2422	(12)
COMP	1	MONOCULTURE	24 3208	2.0267	0.4921	0.2422	(12)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	18.8488	2.3561	0.7395	0.5469	(8)
COMP	1.	MONOCULTURE	18.8488	2.3561	0.7395	0.5469	(8)
SPAC	7.	10 PLANTS M	53.7261	2.8277	1.3196	1.7419	(19)
COMP	1.	MONOCULTURE	21.0710	2.3412	0.4937	0.2437	(9)
COMP	2.	MIXTURE	32.6550	3.2655	1.6785	2.8175	(10)
CUL	6.	70M009002	289.7246	2.2635	1.4769	2.1813	(128)
SPAC	1.	204 PLANTS M	26.3803	1.4656	0.3716	0.1381	(18)
COMP	2.	MIXTURE	26.3803	1.4656	0.3716	0.1381	(18)
SPAC	2.	3 CM SPACING	31.4594	1.4300	0.5217	0.2722	(22)
COMP	2.	MIXTURE	31.4594	1.4300	0.5217	0.2722	(22)
SPAC	3.	9 CM SPACING	28.8265	1.8017	0.8002	0.6403	(16)
COMP	2.	MIXTURE	28.8265	1.8017	0.8002	0.6403	(16)
SPAC	4.	44 PLANTS M	25.8712	2.1559	0.4885	0.2387	(12)
COMP	2.	MIXTURE	25.8712	2.1559	0.4885	0.2387	(12)
SPAC	5.	28 PLANTS M	43.0823	2.3935	1.1272	1.2706	(18)
COMP	2.	MIXTURE	43.0823	2.3935	1.1272	1.2706	(18)
SPAC	6.	17 PLANTS M	61.0168	2.7735	1.7383	3.0216	(22)
COMP	2.	MIXTURE	61.0168	2.7735	1.7383	3.0216	(22)
SPAC	7.	10 PLANTS M	73.0881	3.6544	2.2556	5.0875	(20)
COMP	2.	MIXTURE	73.0881	3.6544	2.2556	5.0875	(20)
CUL	7.	NORQUAY	134.9329	2.0759	1.2933	1.6727	(65)
SPAC	1.	204 PLANTS M	9.3865	1.1733	0.1884	0.0355	(8)
COMP	2.	MIXTURE	9.3865	1.1733	0.1884	0.0355	(8)
SPAC	2.	3 CM SPACING	16.4670	1.4970	0.4180	0.1747	(11)
COMP	1.	MONOCULTURE	10.3046	1.7174	0.4135	0.1710	(6)

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CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	6.1624	1.2325	0.2504	0.0627	(5)
SPAC	3.	9 CM SPACING	11.3371	1.8895	0.6061	0.3673	(6)
COMP	1.	MONOCULTURE	11.3371	1.8895	0.6061	0.3673	(6)
SPAC	4.	44 PLANTS M	11.7366	1.9561	0.4660	0.2171	(6)
COMP	1.	MONOCULTURE	11.7366	1.9561	0.4660	0.2171	(6)
SPAC	5.	28 PLANTS M	15.0879	2.1554	0.6594	0.4347	(7)
COMP	2.	MIXTURE	15.0879	2.1554	0.6594	0.4347	(7)
SPAC	6.	17 PLANTS M	36.6513	2.4434	1.9441	3.7795	(15)
COMP	2.	MIXTURE	36.6513	2.4434	1.9441	3.7795	(15)
SPAC	7.	10 PLANTS M	34.2666	2.8555	1.5594	2.4316	(12)
COMP	1.	MONOCULTURE	20.8884	3.4814	1.6761	2.8092	(6)
COMP	2.	MIXTURE	13.3782	2.2297	1.2650	1.6003	(6)
CUL	8.	NB701	414.3394	2.3019	1.2368	1.5297	(180)
SPAC	1.	204 PLANTS M	45.8612	1.8344	0.2339	0.0547	(25)
COMP	2.	MIXTURE	45.8612	1.8344	0.2339	0.0547	(25)
SPAC	2.	3 CM SPACING	55.3091	1.7842	0.3791	0.1437	(31)
COMP	2.	MIXTURE	55.3091	1.7842	0.3791	0.1437	(31)
SPAC	3.	9 CM SPACING	47.9673	1.9986	0.3191	0.1018	(24)
COMP	2.	MIXTURE	47.9673	1.9986	0.3191	0.1018	(24)
SPAC	4.	44 PLANTS M	65.4665	2.1822	0.6851	0.4693	(30)
COMP	2.	MIXTURE	65.4665	2.1822	0.6851	0.4693	(30)
SPAC	5.	28 PLANTS M	41.6559	2.3142	0.6151	0.3783	(18)
COMP	2.	MIXTURE	41.6559	2.3142	0.6151	0.3783	(18)
SPAC	6.	17 PLANTS M	64.4361	2.8016	1.1684	1.3652	(23)
COMP	2.	MIXTURE	64.4361	2.8016	1.1684	1.3652	(23)

CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	93.6433	3.2291	2.4546	6.0250	(29)
COMP	2.	MIXTURE	93.6433	3.2291	2.4546	6.0250	(29)

TOTAL CASES = 1080
MISSING CASES = 48 OR 4.4 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

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CRITERION VARIABLE KWT WEIGHT PER 1000 KERNELS G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			42569.7974	41.2498	7.2998	53.2866	(1032)
CUL	2	GLENLEA	8851.0077	49.7248	5.0482	25.4840	(178)
SPAC	1	204 PLANTS M	1179.1685	51.2682	3.1304	9.7995	(23)
COMP	1	MONOCULTURE	558.3151	50.7559	3.7974	14.4201	(11)
COMP	2	MIXTURE	620.8534	51.7378	2.4468	5.9868	(12)
SPAC	2	3 CM SPACING	1717.3336	50.5098	4.4477	19.7824	(34)
COMP	1.	MONOCULTURE	650.0408	50.0031	5.5628	30.9445	(13)
COMP	2	MIXTURE	1067.2929	50.8235	3.7154	13.8041	(21)
SPAC	3	9 CM SPACING	1755.1987	50.1485	5.7935	33.5645	(35)
COMP	1	MONOCULTURE	621.7048	47.8234	6.6231	43.8658	(13)
COMP	2	MIXTURE	1133.4939	51.5225	4.8941	23.9522	(22)
SPAC	4.	44 PLANTS M	1379.1382	49.2549	6.5280	42.6150	(28)
COMP	1	MONOCULTURE	641.9000	49.3769	2.3775	5.6525	(13)
COMP	2.	MIXTURE	737.2382	49.1492	8.7929	77.3152	(15)
SPAC	5	26 PLANTS M	956.7977	47.8399	2.1878	4.7864	(20)
COMP	1.	MONOCULTURE	715.7428	47.7162	2.2209	4.9326	(15)
COMP	2.	MIXTURE	241.0549	48.2110	2.2895	5.2419	(5)
SPAC	6.	17 PLANTS M	929.2983	48.9104	7.0853	50.2019	(19)
COMP	1.	MONOCULTURE	603.1059	50.2588	6.7754	45.9056	(12)
COMP	2.	MIXTURE	326.1924	46.5989	7.5217	56.5754	(7)
SPAC	7	10 PLANTS M	934.0726	49.1617	3.1446	9.8884	(19)
COMP	1	MONOCULTURE	407.6655	50.9582	3.2856	10.7951	(8)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	526.4071	47.8552	2.4048	5.7828	(11)
CUL	3.	PARK	7397.8455	35.7384	5.1962	27.0004	(207)
SPAC	1.	204 PLANTS M	929.4865	37.1795	4.9425	24.4284	(25)
COMP	1.	MONOCULTURE	213.5984	35.5997	3.3896	11.4897	(6)
COMP	2.	MIXTURE	715.8881	37.6783	5.3184	28.2850	(19)
SPAC	2.	3 CM SPACING	1465.1311	35.7349	5.5786	31.1204	(41)
COMP	1.	MONOCULTURE	488.9231	34.9231	7.5633	57.2042	(14)
COMP	2.	MIXTURE	976.2080	36.1559	4.3286	18.7365	(27)
SPAC	3.	9 CM SPACING	1137.2260	35.5383	4.9792	24.7926	(32)
COMP	1.	MONOCULTURE	420.7538	35.0628	5.3410	28.5268	(12)
COMP	2.	MIXTURE	716.4722	35.8236	4.8690	23.7071	(20)
SPAC	4.	44 PLANTS M	1033.5158	36.9113	4.8855	23.8678	(28)
COMP	1.	MONOCULTURE	383.8460	34.8951	5.9825	35.7901	(11)
COMP	2.	MIXTURE	649.6698	38.2159	3.6476	13.3050	(17)
SPAC	5.	28 PLANTS M	1031.6960	35.5757	6.5942	43.4834	(29)
COMP	1.	MONOCULTURE	521.7787	34.7852	8.7549	76.6486	(15)
COMP	2.	MIXTURE	509.9173	36.4227	3.1013	9.6183	(14)
SPAC	6.	17 PLANTS M	904.4805	34.7877	5.0639	25.6434	(26)
COMP	1.	MONOCULTURE	461.4736	35.4980	4.0245	16.1967	(13)
COMP	2.	MIXTURE	443.0069	34.0776	6.0112	36.1341	(13)
SPAC	7.	10 PLANTS M	896.3095	34.4734	3.4744	12.0714	(26)
COMP	1.	MONOCULTURE	436.1244	33.5480	2.8678	8.2243	(13)
COMP	2.	MIXTURE	460.1851	35.3989	3.8819	15.0690	(13)
CUL	4.	70M009002	4622.2841	35.8317	5.1398	26.4181	(129)
SPAC	1.	204 PLANTS M	703.2322	35.1616	5.1985	27.0247	(20)
COMP	2.	MIXTURE	703.2322	35.1616	5.1985	27.0247	(20)
SPAC	2.	3 CM SPACING	814.6532	37.0297	4.5510	20.7115	(22)
COMP	2.	MIXTURE	814.6532	37.0297	4.5510	20.7115	(22)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3.	9 CM SPACING	728.6205	36.4310	3.5613	12.6832	(20)
COMP	2.	MIXTURE	728.6205	36.4310	3.5613	12.6832	(20)
SPAC	4.	44 PLANTS M	595.9857	35.0580	7.3110	53.4505	(17)
COMP	2	MIXTURE	595.9857	35.0580	7.3110	53.4505	(17
SPAC	5.	28 PLANTS M	701.9160	36.9429	2.7442	7.5308	(19.
COMP	2	MIXTURE	701.9160	36.9429	2.7442	7.5308	(19)
SPAC	6	17 PLANTS M	711.0827	35.5541	4.8004	23.0438	(20)
COMP	2	MIXTURE	711.0827	35.5541	4.8004	23.0438	(20)
SPAC	7	10 PLANTS M	366.7938	33.3449	7.8268	61.2581	(11
COMP	2	MIXTURE	366.7938	33.3449	7.8268	61.2581	(11
CUL	5.	NOROUAY	6398.3223	44.1264	4.9006	24.0162	(145)
SPAC	1.	204 PLANTS M	1589.6051	45.4173	3.5845	12.8483	(35)
COMP	1.	MONOCULTURE	739.4998	46.2187	2.0899	4.3678	(16.
COMP	2.	MIXTURE	850.1053	44.7424	4.4246	19.5775	(19
SPAC	2.	3 CM SPACING	942.3797	44.8752	5.1560	26.5848	(21)
COMP	1.	MONOCULTURE	415.6354	46.1817	2.2936	5.2604	(9)
COMP	2.	MIXTURE	526.7442	43.8954	6.4859	42.0663	(12)
SPAC	3.	9 CM SPACING	1023.1319	44.4840	3.2981	10.8773	(23)
COMP	1.	MONOCULTURE	457.1795	45.7180	2.0408	4.1649	(10
COMP	2.	MIXTURE	565.9524	43.5348	3.8175	14.5731	(13)
SPAC	4.	44 PLANTS M	1147.2085	42.4892	6.2457	39.0089	(27)
COMP	1	MONOCULTURE	471.4551	42.8596	6.9602	48.4443	(11)
COMP	2	MIXTURE	675.7534	42.2346	5.9287	35.1496	(16)
SPAC	5.	28 PLANTS M	529.2206	44.1017	4.0125	16.1002	(12)
COMP	1	MONOCULTURE	529.2206	44.1017	4.0125	16.1002	(12)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	361.5846	45.1981	6.7857	46.0455	(8)
COMP	1.	MONOCULTURE	361.5846	45.1981	6.7857	46.0455	(8)
SPAC	7.	10 PLANTS M	805.1919	42.3785	5.3964	29.1215	(19)
COMP	1.	MONOCULTURE	381.2081	42.3565	5.3179	28.2797	(9)
COMP	2.	MIXTURE	423.9838	42.3984	5.7537	33.1045	(10)
CUL	6.	70M009002	5509.6012	43.3827	5.6913	32.3903	(127)
SPAC	1.	204 PLANTS M	817.0190	45.3899	6.4339	41.3946	(18)
COMP	2.	MIXTURE	817.0190	45.3899	6.4339	41.3946	(18)
SPAC	2.	3 CM SPACING	1008.1300	45.8241	4.7854	22.9000	(22)
COMP	2.	MIXTURE	1008.1300	45.8241	4.7854	22.9000	(22)
SPAC	3.	9 CM SPACING	714.0318	44.6270	5.6788	32.2483	(16)
COMP	2.	MIXTURE	714.0318	44.6270	5.6788	32.2483	(16)
SPAC	4.	44 PLANTS M	514.9796	42.9150	5.3435	28.5530	(12)
COMP	2.	MIXTURE	514.9796	42.9150	5.3435	28.5530	(12)
SPAC	5.	28 PLANTS M	727.0364	40.3909	5.9079	34.9035	(18)
COMP	2.	MIXTURE	727.0364	40.3909	5.9079	34.9035	(18)
SPAC	6.	17 PLANTS M	890.3559	42.3979	4.6556	21.6742	(21)
COMP	2.	MIXTURE	890.3559	42.3979	4.6556	21.6742	(21)
SPAC	7.	10 PLANTS M	838.0485	41.9024	5.6920	32.3984	(20)
COMP	2.	MIXTURE	838.0485	41.9024	5.6920	32.3984	(20)
CUL	7.	NORQUAY	2374.6733	36.5334	5.0738	25.7431	(65)
SPAC	1.	204 PLANTS M	312.4172	39.0521	4.1520	17.2392	(8)
COMP	2.	MIXTURE	312.4172	39.0521	4.1520	17.2392	(8)
SPAC	2.	3 CM SPACING	419.3873	38.1261	2.9215	8.5354	(11)
COMP	1.	MONOCULTURE	225.1768	37.5295	3.2046	10.2694	(6)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	194.2105	38.8421	2.7069	7.3271	(5)
SPAC	3.	9 CM SPACING	203.8732	33.9789	7.1510	51.1364	(6)
COMP	1.	MONOCULTURE	203.8732	33.9789	7.1510	51.1364	(6)
SPAC	4.	44 PLANTS M	219.8699	36.6450	6.6840	44.6757	(6)
COMP	1.	MONOCULTURE	219.8699	36.6450	6.6840	44.6757	(6)
SPAC	5.	28 PLANTS M	264.9277	37.8468	3.5307	12.4659	(7)
COMP	2.	MIXTURE	264.9277	37.8468	3.5307	12.4659	(7)
SPAC	6.	17 PLANTS M	537.0554	35.8037	4.6429	21.5563	(15)
COMP	2.	MIXTURE	537.0554	35.8037	4.6429	21.5563	(15)
SPAC	7.	10 PLANTS M	417.1427	34.7619	6.1072	37.2980	(12)
COMP	1.	MONOCULTURE	225.4355	37.5726	3.7267	13.8882	(6)
COMP	2.	MIXTURE	191.7072	31.9512	7.0148	49.2074	(6)
CUL	8.	NB701	7416.0633	40.9727	5.8690	34.4457	(181)
SPAC	1.	204 PLANTS M	1061.6588	42.4664	3.7838	14.3171	(25)
COMP	2.	MIXTURE	1061.6588	42.4664	3.7838	14.3171	(25)
SPAC	2.	3 CM SPACING	1358.1026	42.4407	5.1420	26.4404	(32)
COMP	2.	MIXTURE	1358.1026	42.4407	5.1420	26.4404	(32)
SPAC	3.	9 CM SPACING	1047.5367	43.6474	4.3314	18.7612	(24)
COMP	2.	MIXTURE	1047.5367	43.6474	4.3314	18.7612	(24)
SPAC	4.	44 PLANTS M	1237.6341	41.2545	4.2021	17.6573	(30)
COMP	2.	MIXTURE	1237.6341	41.2545	4.2021	17.6573	(30)
SPAC	5.	28 PLANTS M	733.9242	40.7736	6.0767	36.9258	(18)
COMP	2.	MIXTURE	733.9242	40.7736	6.0767	36.9258	(18)
SPAC	6.	17 PLANTS M	896.3368	38.9712	5.6575	32.0074	(23)
COMP	2.	MIXTURE	896.3368	38.9712	5.6575	32.0074	(23)

CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	7.	10 PLANTS M	1080.8703	37.2714	8.3933	70.4478	(29)
COMP	2.	MIXTURE	1080.8703	37.2714	8.3933	70.4478	(29)

TOTAL CASES = 1080
MISSING CASES = 48 OR 4.4 PCT.

FILE WP77 (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE HI HARVEST INDEX
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			7090.3000	6.8771	47.6762	2273.0192	(1031)
CUL	2	GLENLEA	685.8161	3.8314	2.0483	4 1955	(179)
SPAC	1	204 PLANTS M	106.5466	4.6325	1 3347	1 7815	(23)
COMP	1.	MONOCULTURE	57.5437	5.2312	1.4866	2.2105	(11)
COMP	2	MIXTURE	49.0029	4.0836	0.9307	0.8663	(12)
SPAC	2	3 CM SPACING	158.6169	4.6652	2.1069	4.4390	(34)
COMP	1.	MONOCULTURE	70.8353	5.4489	3.0529	9 3204	(13)
COMP	2.	MIXTURE	87.7815	4.1801	1.0420	1.0858	(21)
SPAC	3.	9 CM SPACING	150.3601	4.2960	2.1012	4.4152	(35)
COMP	1	MONOCULTURE	66.5879	5.1221	2 7883	7.7747	(13)
COMP	2.	MIXTURE	83.7722	3.8078	1.4260	2.0335	(22)
SPAC	4	44 PLANTS M	108.2077	3.8646	3.1384	9.8493	(28)
COMP	1.	MONOCULTURE	42.6167	3.2782	0.3555	0.1264	(13)
COMP	2	MIXTURE	65.5911	4.3727	4.2768	18.2908	(15)
SPAC	5	28 PLANTS M	58.9322	2.9466	0.3907	0.1527	(20)
COMP	1.	MONOCULTURE	45.9526	3.0635	0.3804	0.1447	(15)
COMP	2.	MIXTURE	12.9796	2.5959	0 1168	0.0136	(5)
SPAC	6	17 PLANTS M	55.6079	2.7804	0.4550	0.2070	(20)
COMP	1.	MONOCULTURE	36.9250	2.8404	0.4082	0.1666	(13)
COMP	2.	MIXTURE	18.6829	2.6690	0.5479	0.3001	(7)
SPAC	7	10 PLANTS M	47.5447	2.5024	1.0789	1.1640	(19)
COMP	1.	MONOCULTURE	24.5729	3.0716	1.4293	2.0430	(8)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	22.9718	2.0883	0.4661	0.2173	(11)
CUL	3.	PARK	2459.8824	11.9412	98.5800	9718.0083	(206)
SPAC	1.	204 PLANTS M	196.4007	7.8560	6.1531	37.8602	(25)
COMP	1.	MONOCULTURE	55.9563	9.3260	8.9871	80.7689	(6)
COMP	2.	MIXTURE	140.4444	7.3918	5.2054	27.0966	(19)
SPAC	2.	3 CM SPACING	1704.3878	41.5704	220.5585	48646.0596	(41)
COMP	1.	MONOCULTURE	1479.7354	105.6954	377.9959	142880.9129	(14)
COMP	2.	MIXTURE	224.6524	8.3205	6.1151	37.3941	(27)
SPAC	3.	9 CM SPACING	151.5544	4.7361	1.3130	1.7241	(32)
COMP	1.	MONOCULTURE	51.8588	4.3216	0.8113	0.6583	(12)
COMP	2.	MIXTURE	99.6956	4.9848	1.5027	2.2582	(20)
SPAC	4.	44 PLANTS M	105.2896	3.8996	0.5695	0.3244	(27)
COMP	1.	MONOCULTURE	44.9796	4.0891	0.6515	0.4244	(11)
COMP	2.	MIXTURE	60.3100	3.7694	0.4847	0.2349	(16)
SPAC	5.	28 PLANTS M	104.8810	3.6166	1.1279	1.2721	(29)
COMP	1.	MONOCULTURE	59.4854	3.9657	1.4262	2.0339	(15)
COMP	2.	MIXTURE	45.3956	3.2425	0.5081	0.2582	(14)
SPAC	6.	17 PLANTS M	94.3217	3.6278	0.8367	0.7000	(26)
COMP	1.	MONOCULTURE	43.8776	3.3752	0.6377	0.4067	(13)
COMP	2.	MIXTURE	50.4440	3.8803	0.9558	0.9135	(13)
SPAC	7.	10 PLANTS M	103.0472	3.9634	1.3599	1.8492	(26)
COMP	1.	MONOCULTURE	57.1319	4.3948	1.7825	3.1774	(13)
COMP	2.	MIXTURE	45.9154	3.5320	0.5214	0.2719	(13)
CUL	4.	70M009002	690.1436	5.3500	6.4851	42.0561	(129)
SPAC	1.	204 PLANTS M	210.7993	10.5400	13.6875	187.3483	(20)
COMP	2.	MIXTURE	210.7993	10.5400	13.6875	187.3483	(20)
SPAC	2.	3 CM SPACING	145.3857	6.6084	5.9455	35.3485	(22)
COMP	2.	MIXTURE	145.3857	6.6084	5.9455	35.3485	(22)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	3	9 CM SPACING	86.6497	4.3325	1.2834	1.6470	(20)
COMP	2.	MIXTURE	86.6497	4.3325	1.2834	1.6470	(20)
SPAC	4	44 PLANTS M	76.2048	4.4826	3.2895	10.8206	(17)
COMP	2	MIXTURE	76.2048	4.4826	3.2895	10.8206	(17)
SPAC	5	28 PLANTS M	63.4971	3.3420	0.5705	0.3254	(19)
COMP	2	MIXTURE	63.4971	3.3420	0.5705	0.3254	(19)
SPAC	6.	17 PLANTS M	65.7445	3.2872	1.0308	1.0626	(20)
COMP	2.	MIXTURE	65.7445	3.2872	1.0308	1.0626	(20)
SPAC	7.	10 PLANTS M	41.8625	3.8057	2.3618	5.5779	(11)
COMP	2.	MIXTURE	41.8625	3.8057	2.3618	5.5779	(11)
CUL	5	NORQUAY	1205.5454	8.3141	38.7419	1500.9368	(145)
SPAC	1.	204 PLANTS M	292.2497	8.3500	11.4493	131.0864	(35)
COMP	1	MONOCULTURE	74.0697	4.6294	1.4521	2.1086	(16)
COMP	2.	MIXTURE	218.1800	11.4832	14.9393	223.1834	(19)
SPAC	2.	3 CM SPACING	554.8683	26.4223	100.4278	10085.7416	(21)
COMP	1.	MONOCULTURE	35.7108	3.9679	1.0591	1.1218	(9)
COMP	2.	MIXTURE	519.1576	43.2631	132.7214	17614.9708	(12)
SPAC	3.	9 CM SPACING	100.0289	4.3491	1.5278	2.3340	(23)
COMP	1.	MONOCULTURE	39.3409	3.9341	0.9333	0.8710	(10)
COMP	2.	MIXTURE	60.6879	4.6683	1.8363	3.3719	(13)
SPAC	4.	44 PLANTS M	111.3691	4.1248	3.3122	10.9708	(27)
COMP	1.	MONOCULTURE	41.6104	3.7828	3.0698	9.4239	(11)
COMP	2.	MIXTURE	69.7587	4.3599	3.5480	12.5886	(16)
SPAC	5.	28 PLANTS M	41.9124	3.4927	2.0334	4.1346	(12)
COMP	1	MONOCULTURE	41.9124	3.4927	2.0334	4.1346	(12)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
SPAC	6.	17 PLANTS M	53.5378	6.6922	11.6935	136.7369	(8)
COMP	1.	MONOCULTURE	53.5378	6.6922	11.6935	136.7369	(8)
SPAC	7.	10 PLANTS M	51.5792	2.7147	0.6077	0.3693	(19)
COMP	1.	MONOCULTURE	25.0369	2.7819	0.7616	0.5800	(9)
COMP	2.	MIXTURE	26.5422	2.6542	0.4631	0.2144	(10)
CUL	6.	70M009002	822.4952	6.4763	14.0770	198.1618	(127)
SPAC	1.	204 PLANTS M	159.4744	8.8597	12.5365	157.1637	(18)
COMP	2.	MIXTURE	159.4744	8.8597	12.5365	157.1637	(18)
SPAC	2.	3 CM SPACING	334.6325	15.9349	30.8583	952.2333	(21)
COMP	2.	MIXTURE	334.6325	15.9349	30.8583	952.2333	(21)
SPAC	3.	9 CM SPACING	78.1596	4.8850	1.7780	3.1614	(16)
COMP	2.	MIXTURE	78.1596	4.8850	1.7780	3.1614	(16)
SPAC	4	44 PLANTS M	41.3023	3.4419	0.7260	0.5271	(12)
COMP	2.	MIXTURE	41.3023	3.4419	0.7260	0.5271	(12)
SPAC	5.	28 PLANTS M	66.5322	3.6962	1.4647	2.1455	(18)
COMP	2	MIXTURE	66.5322	3.6962	1.4647	2.1455	(18)
SPAC	6	17 PLANTS M	90.7894	4.1268	4.6886	21.9834	(22)
COMP	2.	MIXTURE	90.7894	4.1268	4.6886	21.9834	(22)
SPAC	7	10 PLANTS M	51.6049	2.5802	0.4827	0.2330	(20)
COMP	2.	MIXTURE	51.6049	2.5802	0.4827	0.2330	(20)
CUL	7.	NOROUAY	246.7083	3.7955	1.8413	3.3904	(65)
SPAC	1.	204 PLANTS M	41.1016	5.1377	0.8211	0.6742	(8)
COMP	2.	MIXTURE	41.1016	5.1377	0.8211	0.6742	(8)
SPAC	2.	3 CM SPACING	47.4565	4.3142	1.6513	2.7267	(11)
COMP	1.	MONOCULTURE	24.6875	4.1146	2.2202	4.9295	(6)

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CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
COMP	2.	MIXTURE	22.7690	4.5538	0.7235	0.5235	(5)
SPAC	3.	9 CM SPACING	23.2224	3.8704	2.3779	5.6542	(6)
COMP	1.	MONOCULTURE	23.2224	3.8704	2.3779	5.6542	(6)
SPAC	4	44 PLANTS M	20.7435	3.4572	1.0709	1.1469	(6)
COMP	1	MONOCULTURE	20.7435	3.4572	1.0709	1.1469	(6)
SPAC	5	28 PLANTS M	20.1940	2.8849	0.3229	0.1043	(7)
COMP	2	MIXTURE	20.1940	2.8849	0.3229	0.1043	(7)
SPAC	6	17 PLANTS M	49.6140	3.3076	0.7006	0.4908	(15)
COMP	2	MIXTURE	49.6140	3.3076	0.7006	0.4908	(15)
SPAC	7	10 PLANTS M	44.3762	3.6980	3.2461	10.5375	(12)
COMP	1.	MONOCULTURE	14.8619	2.4770	0.4423	0.1957	(6)
COMP	2.	MIXTURE	29.5143	4.9191	4.4055	19.4086	(6)
CUL	8.	NB701	979.7090	5.4428	22.7957	519.6441	(180)
SPAC	1.	204 PLANTS M	110.3690	4.4148	0.9386	0.8810	(25)
COMP	2.	MIXTURE	110.3690	4.4148	0.9386	0.8810	(25)
SPAC	2	3 CM SPACING	448.8609	14.4794	54.6447	2986.0378	(31)
COMP	2	MIXTURE	448.8609	14.4794	54.6447	2986.0378	(31)
SPAC	3	9 CM SPACING	94.0102	3.9171	1.3225	1.7491	(24)
COMP	2	MIXTURE	94.0102	3.9171	1.3225	1.7491	(24)
SPAC	4	44 PLANTS M	117.9122	[illegible].9304	2.8098	7.8951	(30)
COMP	2	MIXTURE	117.9122	3.9304	2.8098	7.8951	(30)
SPAC	5.	28 PLANTS M	51.4064	2.8559	0.4271	0.1824	(18)
COMP	2	MIXTURE	51.4064	2.8559	0.4271	0.1824	(18)
SPAC	6	17 PLANTS M	70.6120	3.0701	1.0511	1.1048	(23)
COMP	2	MIXTURE	70.6120	3.0701	1.0511	1.1048	(23)
SPAC	7.	10 PLANTS M	86.5383	2.9841	0.5917	0.3501	(29)
COMP	2.	MIXTURE	86.5383	2.9841	0.5917	0.3501	(29)

TOTAL CASES = 1080
MISSING CASES = 49 OR 4.5 PCT.

Appendix 7. Descriptive statistics of characters of plants, grown in monoculture and in mixture at two interplant spacings, measured at maturity in 1978.

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FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE T TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3417.0000	6 0053	3.1273	8 7799	(569)
CUL	1.	PITIC 62	570 0000	6 9512	4.3600	19 0099	(82)
SPAC	2	3 CM SPACING	217 0000	4 5208	1.3989	1.9570	(48)
MTR	2.	MIXTURE	217 0000	4 5208	1.3989	1 9570	(48)
SPAC	3	9 CM SPACING	353 0000	10.3824	4.8117	23 1524	(34
MTR	2	MIXTURE	353 0000	10 3824	4 8117	23.1524	(34)
CUL	2	GLENLEA	958 0000	5 6353	3.0840	9 5112	(170)
SPAC	2	3 CM SPACING	309 0000	3 6786	1.1633	1 3533	(84)
MTR	1.	MONOCULTURE	62 0000	3 4444	0.9218	0 8497	(18)
MTR	2	MIXTURE	247 0000	3 7424	1.2192	1.4865	(66)
SPAC	3.	9 CM SPACING	649 0000	7.5465	3.1796	10.1096	(86)
MTR	1	MONOCULTURE	113 0000	6.2778	2.4448	5.9771	(18)
MTR	2	MIXTURE	536 0000	7 8824	3.2806	10 7621	(68)
CUL	3	PARK	758 0000	5.9685	2.3869	5 6974	(127)
SPAC	2.	3 CM SPACING	304 0000	4.6769	1 3931	1 9409	(65)
MTR	1	MONOCULTURE	59 0000	5 3636	0.8090	0 6545	(11)
MTR	2	MIXTURE	245 0000	4 5370	1.4500	2 1024	(54
SPAC	3	9 CM SPACING	454 0000	7 3226	2.4680	6.0910	(62)
MTR	1	MONOCULTURE	113 0000	9 4167	2.2344	4 9924	12)
MTR	2	MIXTURE	341 0000	6.8200	2.2650	5 1302	(50)
CUL	4	70M009002	550 0000	5 8511	2 6959	7 2679	(94)
SPAC	2	3 CM SPACING	189 0000	4 1087	1.1201	1.2546	(46)
MTR	1.	MONOCULTURE	77 0000	4 2778	1.0741	1 1536	(18)

CRITERION VARIABLE T

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	112.0000	4.0000	1.1547	1.3333	(28)
SPAC	3.	9 CM SPACING	361.0000	7.5208	2.7132	7.3613	(48)
MTR	1.	MONOCULTURE	144.0000	8.0000	2.9506	8.7059	(18)
MTR	2.	MIXTURE	217.0000	7.2333	2.5688	6.5989	(30)
CUL	5.	NORQUAY	581.0000	6.0521	3.1030	9.6288	(96)
SPAC	2.	3 CM SPACING	143.0000	3.9722	1.6816	2.8278	(36)
MTR	1.	MONOCULTURE	70.0000	3.8889	1.2783	1.6340	(18)
MTR	2.	MIXTURE	73.0000	4.0556	2.0428	4.1732	(18)
SPAC	3.	9 CM SPACING	438.0000	7.3000	3.0989	9.6034	(60)
MTR	1.	MONOCULTURE	138.0000	7.6667	3.1808	10.1176	(18)
MTR	2.	MIXTURE	300.0000	7.1429	3.0887	9.5401	(42)

TOTAL CASES = 570
MISSING CASES = 1 OR 0.2 PCT.

FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE H HEADS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3043.0000	5.3480	2.6381	6.9597	(569)
CUL	1	PITIC 62	464.0000	5.6585	3.1040	9.6350	(82)
SPAC	2	3 CM SPACING	187.0000	3.8958	1.4178	2.0102	(48)
MTR	2	MIXTURE	187.0000	3.8958	1.4178	2.0102	(48)
SPAC	3.	9 CM SPACING	277.0000	8.1471	3.1443	9.8868	(34)
MTR	2	MIXTURE	277.0000	8.1471	3.1443	9.8868	(34)
CUL	2	GLENLEA	806.0000	4.7412	2.4430	5.9681	(170)
SPAC	2.	3 CM SPACING	272.0000	3.2381	1.0014	1.0029	(84)
MTR	1	MONOCULTURE	55.0000	3.0556	1.0556	1.1144	(18)
MTR	2	MIXTURE	217.0000	3.2879	0.9886	0.9774	(66)
SPAC	3	9 CM SPACING	534.0000	6.2093	2.5443	6.4733	(86)
MTR	1.	MONOCULTURE	86.0000	4.7778	1.7675	3.1242	(18)
MTR	2	MIXTURE	448.0000	6.5882	2.5930	6.7234	(68)
CUL	3.	PARK	709.0000	5.5827	2.1983	4.8324	(127)
SPAC	2.	3 CM SPACING	291.0000	4.4769	1.3123	1.7221	(65)
MTR	1	MONOCULTURE	58.0000	5.2727	0.9045	0.8182	(11)
MTR	2.	MIXTURE	233.0000	4.3148	1.3293	1.7669	(54)
SPAC	3	9 CM SPACING	418.0000	6.7419	2.3465	5.5061	(62)
MTR	1.	MONOCULTURE	99.0000	8.2500	2.3404	5.4773	(12)
MTR	2	MIXTURE	319.0000	6.3800	2.2213	4.9343	(50)
CUL	4	70M009002	530.0000	5.6383	2.6795	7.1796	(94)
SPAC	2.	3 CM SPACING	183.0000	3.9783	1.1830	1.3995	(46)
MTR	1.	MONOCULTURE	74.0000	4.1111	1.1318	1.2810	(18)

CRITERION VARIABLE H

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	109.0000	3.8929	1.2274	1.5066	(28)
SPAC	3.	9 CM SPACING	347.0000	7.2292	2.7540	7.5847	(48)
MTR	1.	MONOCULTURE	133.0000	7.3889	3.0705	9.4281	(18)
MTR	2.	MIXTURE	214.0000	7.1333	2.5962	6.7402	(30)
CUL	5.	NORQUAY	534.0000	5.5625	2.8976	8.3961	(96)
SPAC	2.	3 CM SPACING	133.0000	3.6944	1.2380	1.5325	(36)
MTR	1.	MONOCULTURE	70.0000	3.8889	1.2783	1.6340	(18)
MTR	2.	MIXTURE	63.0000	3.5000	1.2005	1.4412	(18)
SPAC	3.	9 CM SPACING	401.0000	6.6833	3.0337	9.2031	(60)
MTR	1.	MONOCULTURE	124.0000	6.8889	3.1039	9.6340	(18)
MTR	2.	MIXTURE	277.0000	6.5952	3.0368	9.2224	(42)

TOTAL CASES = 570
MISSING CASES = 1 OR 0.2 PCT.

FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE WT DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			11137.6952	19.7127	12.0696	145.6751	(565)
CUL	1.	PITIC 62	1775.1194	21.6478	14.5053	210.4028	(82)
SPAC	2.	3 CM SPACING	635.3297	13.2360	4.9013	24.0230	(48)
MTR	2.	MIXTURE	635.3297	13.2360	4.9013	24.0230	(48)
SPAC	3.	9 CM SPACING	1139.7897	33.5232	15.2973	234 0089	(34)
MTR	2.	MIXTURE	1139.7897	33.5232	15.2973	234.0089	(34)
CUL	2.	GLENLEA	3857.6485	22.9622	13.7537	189 1642	(168)
SPAC	2.	3 CM SPACING	1147.4994	13.8253	4.6787	21.8899	(83)
MTR	1.	MONOCULTURE	207.3399	12.1965	4.6706	21.8146	(17)
MTR	2.	MIXTURE	940.1595	14.2448	4.6230	21.3726	(66)
SPAC	3.	9 CM SPACING	2710.1491	31.8841	13.8445	191.6705	(85)
MTR	1.	MONOCULTURE	476.2798	26.4600	10.1377	102.7738	(18)
MTR	2.	MIXTURE	2233.8694	33.3413	14.3977	207.2926	(67)
CUL	3.	PARK	1814.6990	14.2890	6.9702	48.5831	(127)
SPAC	2.	3 CM SPACING	670.3196	10.3126	3.7953	14.4042	(65)
MTR	1.	MONOCULTURE	151.4399	12.6200	2.5188	6.3443	(12)
MTR	2.	MIXTURE	518.8797	9.7902	3.8574	14.8793	(53)
SPAC	3.	9 CM SPACING	1144.3794	18.4577	7.1223	50.7277	(62)
MTR	1.	MONOCULTURE	309.6199	25.8017	7.2732	52.8999	(12)
MTR	2.	MIXTURE	834.7595	16.6952	5.9074	34.8973	(50)
CUL	4.	70M009002	1826.4692	19.8529	10.7864	116.3472	(92)
SPAC	2.	3 CM SPACING	545.9896	12.4089	3.6978	13.6739	(44)
MTR	1.	MONOCULTURE	230.1099	14.3819	3.7247	13.8731	(16)

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CRITERION VARIABLE WT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	315.8798	11.2814	3.2318	10.4446	(28)
SPAC	3.	9 CM SPACING	1280.4796	26.6767	10.6455	113.3268	(48)
MTR	1.	MONOCULTURE	528.2398	29.3467	12.3521	152.5742	(18)
MTR	2.	MIXTURE	752.2397	25.0747	9.3353	87.1477	(30)
CUL	5.	NOROUAY	1863.7592	19.4142	10.7563	115.6984	(96)
SPAC	2.	3 CM SPACING	427.7998	11.8833	5.0817	25.8232	(36)
MTR	1.	MONOCULTURE	245.0399	13.6133	4.5671	20.8587	(18)
MTR	2.	MIXTURE	182.7599	10.1533	5.0960	25.9689	(18)
SPAC	3.	9 CM SPACING	1435.9594	23.9327	10.7521	115.6075	(60)
MTR	1.	MONOCULTURE	452.8698	25.1594	11.1242	123.7483	(18)
MTR	2.	MIXTURE	983.0896	23.4069	10.6821	114.1078	(42)

TOTAL CASES = 570
MISSING CASES = 5 OR 0.9 PCT.

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FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - -

CRITERION VARIABLE Y SEED YIELD PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			4901 1980	8 5986	5 4054	29 2182	(570)
CUL	1	PITIC 62	777 5997	9 4829	6 3216	39 9621	(82)
SPAC	2	3 CM SPACING	279 9999	5 8333	2 4968	6 2342	(48)
MTR	2	MIXTURE	279.9999	5 8333	2.4968	6.2342	(48)
SPAC	3	9 CM SPACING	497.5998	14 6353	6.5180	42 4847	(34)
MTR	2	MIXTURE	497 5998	14.6353	6 5180	42 4847	(34)
CUL	2	GLENLEA	1676 1992	9.8600	5.9197	35 0428	(170)
SPAC	2	3 CM SPACING	504 5998	6 0071	2 0845	4 3452	(84)
MTR	1	MONOCULTURE	94 9000	5 2722	2.2557	5 0880	(18)
MTR	2	MIXTURE	409.6998	6.2076	2 0069	4 0275	(66)
SPAC	3.	9 CM SPACING	1171 5994	13 6232	6.0359	36 4319	(86)
MTR	1	MONOCULTURE	194.6999	10.8167	4.3017	18 5050	(18)
MTR	2.	MIXTURE	976.8995	14.3662	6.2328	38.8479	(68)
CUL	3.	PARK	747.6997	5 8414	3.0273	9.1643	(128)
SPAC	2	3 CM SPACING	271 8999	4 1197	1 6267	2.6462	(66)
MTR	1.	MONOCULTURE	60.2000	5 0167	1 2946	1.6761	(12)
MTR	2.	MIXTURE	211.6999	3 9204	1 6355	2.6749	(54)
SPAC	3	9 CM SPACING	475 7995	[illegible] 6742	3 1046	9.6387	(62)
MTR	1	MONOCULTURE	127 3000	[illegible]	3.2643	10 6554	(12)
MTR	2	MIXTURE	348.4999	[illegible]	2.6444	6 9928	(50)
CUL	4.	70M009002	860 859[illegible]	[illegible] 1585	5.1524	26.5471	(94)
SPAC	2	3 CM SPACING	260.69[illegible]	[illegible] 6674	1.7923	3.2125	(46)
MTR	1	MONOCULTURE	117.80[illegible]	[illegible] 5444	[illegible].8971	3.5991	(18)

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CRITERION VARIABLE Y

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	142.8999	5.1036	1.4985	2.2455	(28)
SPAC	3.	9 CM SPACING	600.1998	12.5042	5.1082	26.0936	(48)
MTR	1.	MONOCULTURE	241.7999	13.4333	5.7364	32.9058	(18)
MTR	2.	MIXTURE	358.3999	11.9467	4.7056	22.1425	(30)
CUL	5.	NOROUAY	838.7997	8.7375	5.1240	26.2552	(96)
SPAC	2.	3 CM SPACING	187.3999	5.2056	2.2877	5.2337	(36)
MTR	1.	MONOCULTURE	108.9000	6.0500	2.0523	4.2121	(18)
MTR	2.	MIXTURE	78.5000	4.3611	2.2479	5.0531	(18)
SPAC	3.	9 CM SPACING	651.3998	10.8567	5.1954	26.9920	(60)
MTR	1.	MONOCULTURE	207.5999	11.5333	5.4485	29.6858	(18)
MTR	2.	MIXTURE	443.7999	10.5667	5.1231	26.2462	(42)

TOTAL CASES = 570

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FILE SPMERG (CREATION DATE = 12/30/81)

\- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE NK NUMBER OF KERNELS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			119998.0000	210.5228	126.6219	16033.1111	(570)
CUL	1.	PITIC 62	21420.0000	261.2195	173.2322	30009.3833	(82)
SPAC	2.	3 CM SPACING	7864.0000	163.8333	65.1056	4238.7376	(48)
MTR	2.	MIXTURE	7864.0000	163.8333	65.1056	4238.7376	(48)
SPAC	3.	9 CM SPACING	13556.0000	398.7059	185.3432	34352.0927	(34)
MTR	2.	MIXTURE	13556.0000	398.7059	185.3432	34352.0927	(34)
CUL	2.	GLENLEA	33728.0000	198.4000	112.2653	12603.5077	(170)
SPAC	2.	3 CM SPACING	10471.0000	124.6548	40.8726	1670.5661	(84)
MTR	1.	MONOCULTURE	2057.0000	114.2778	45.7497	2093.0359	(18)
MTR	2.	MIXTURE	8414.0000	127.4848	39.3424	1547.8228	(66)
SPAC	3.	9 CM SPACING	23257.0000	270.4302	113.1535	12803.7068	(86)
MTR	1.	MONOCULTURE	3902.0000	216.7778	85.5883	7325.3595	(18)
MTR	2.	MIXTURE	19355.0000	284.6324	115.7876	13406.7733	(68)
CUL	3.	PARK	21267.0000	166.1484	81.2985	6609.4502	(128)
SPAC	2.	3 CM SPACING	7861.0000	119.1061	44.2876	1961.3886	(66)
MTR	1.	MONOCULTURE	1678.0000	139.8333	35.9212	1290.3333	(12)
MTR	2.	MIXTURE	6183.0000	114.5000	44.9309	2018.7830	(54)
SPAC	3.	9 CM SPACING	13406.0000	216.2258	82.0209	6727.4236	(62)
MTR	1.	MONOCULTURE	3517.0000	293.0833	84.0881	7070.8106	(12)
MTR	2.	MIXTURE	9889.0000	197.7800	70.6669	4993.8078	(50)
CUL	4.	70M009002	22203.0000	236.202	125.9310	15858.6146	(94)
SPAC	2.	3 CM SPACING	7133.0000	155.06	44.1701	1950.9957	(46)
MTR	1.	MONOCULTURE	3131.0000	173.94	44.1741	1951.3497	(18

CRITERION VARIABLE NK

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	4002.0000	142.9286	40.4062	1632.6614	(28)
SPAC	3.	9 CM SPACING	15070.0000	313.9583	129.9771	16894.0408	(48)
MTR	1.	MONOCULTURE	5912.0000	328.4444	145.4196	21146.8497	(18)
MTR	2.	MIXTURE	9158.0000	305.2667	121.5531	14775.1678	(30)
CUL	5.	NORQUAY	21380.0000	222.7083	133.1329	17724.3772	(96)
SPAC	2.	3 CM SPACING	4735.0000	131.5278	55.3428	3062.8278	(36)
MTR	1.	MONOCULTURE	2720.0000	151.1111	50.7994	2580.5752	(18)
MTR	2.	MIXTURE	2015.0000	111.9444	53.9733	2913.1144	(18)
SPAC	3.	9 CM SPACING	16645.0000	277.4167	136.4027	18605.7048	(60)
MTR	1.	MONOCULTURE	5322.0000	295.6667	145.2677	21102.7059	(18)
MTR	2.	MIXTURE	11323.0000	269.5952	133.4739	17815.2712	(42)

TOTAL CASES = 570

FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE KWT WEIGHT PER 1000 KERNELS G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			23118.3103	40.5584	6.9782	48.6952	(570)
CUL	1.	PITIC 62	2986 5823	36.4217	4 4198	19.5343	(82)
SPAC	2.	3 CM SPACING	1718.9851	35 8122	4.9272	24.2776	(48)
MTR	2.	MIXTURE	1718.9851	35.8122	4.9272	24.2776	(48.
SPAC	3.	9 CM SPACING	1267.5972	37.2823	3.4738	12.0671	(34)
MTR	2.	MIXTURE	1267.5972	37.2823	3.4738	12.0671	(34)
CUL	2.	GLENLEA	8322.3251	48.9549	4.7343	22.4139	(170)
SPAC	2.	3 CM SPACING	4036 4008	48.0524	4.9260	24.2650	(84·
MTR	1.	MONOCULTURE	826.7813	45.9323	7.5025	56.2883	(18)
MTR	2.	MIXTURE	3209.6194	48.6306	3.8313	14.6789	(66)
SPAC	3.	9 CM SPACING	4285 9244	49.8363	4.3908	19.2790	(86)
MTR	1.	MONOCULTURE	892 5471	49.5859	3.4094	11.6239	(18)
MTR	2.	MIXTURE	3393.3773	49.9026	4.6355	21.4878	(68)
CUL	3.	PARK	4441.9273	34.7026	3.5233	12.4137	(128)
SPAC	2.	3 CM SPACING	2262.5280	34.2807	2.8128	7.9121	(66)
MTR	1.	MONOCULTURE	430.5100	35.8758	1.6824	2.8304	(12)
MTR	2.	MIXTURE	1832.0180	33.9263	2.9003	8.4120	(54)
SPAC	3.	9 CM SPACING	2179.3994	35 1516	4.1251	17.0165	(62)
MTR	1.	MONOCULTURE	432.1547	36 0129	1.1382	1.2956	(12)
MTR	2.	MIXTURE	1747.2447	34.9449	4.5462	20.6677	(50)
CUL	4.	70M009002	3587.3030	38.1628	3.9839	15.8711	(94)
SPAC	2.	3 CM SPACING	1671.2930	36.3325	3.9205	15.3700	(46)
MTR	1.	MONOCULTURE	672.7794	37.3766	3.2713	10.7015	(18)

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CRITERION VARIABLE KWT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	998.5136	35.6612	4.2053	17.6846	(28)
SPAC	3	9 CM SPACING	1916.0100	[illegible].9169	3.2043	10.2674	(48)
MTR	1.	MONOCULTURE	740.1386	41.1188	2.6103	6.8137	(18)
MTR	2.	MIXTURE	1175.8714	39.1957	3.3483	11.2113	(30)
CUL	5.	NORQUAY	3780.1725	39.3768	2.9626	8.7767	(96)
SPAC	2.	3 CM SPACING	1415.0612	39.3073	2.5848	6.6814	(36)
MTR	1.	MONOCULTURE	723.7060	40.2059	2.0196	4.0787	(18)
MTR	2.	MIXTURE	691.3552	38.4086	2.8226	7.9670	(18)
SPAC	3.	9 CM SPACING	2365.1113	39.4185	3.1881	10.1638	(60)
MTR	1.	MONOCULTURE	710.6705	[illegible].4817	1.8684	3.4908	(18)
MTR	2.	MIXTURE	1654.4408	39.3914	3.6299	13.1760	(42)

TOTAL CASES = 570

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FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE KH NUMBER OF KERNELS PER HEAD
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			22094 1702	38.8298	9.9444	98 8913	(569)
CUL	1	PITIC 62	3721 0492	45 3786	12 2144	149 1927	(82)
SPAC	2	3 CM SPACING	2066 7499	43 0573	13 2479	175 5063	(48)
MTR	2	MIXTURE	2066 7499	43.0573	13 2479	175 5063	(48
SPAC	3	9 CM SPACING	1654 2993	48 6559	9.8657	97 3329	(34
MTR	2	MIXTURE	1654 2993	48 6559	9.8657	97 3329	(34)
CUL	2	GLENLEA	7029 0519	41.3474	7.2583	52 6823	(170)
SPAC	2	3 CM SPACING	3248 8998	38 6774	6 1353	37 6419	(84)
MTR	1	MONOCULTURE	670 7499	37.2639	6.1714	38 0860	(18)
MTR	2.	MIXTURE	2578 1499	39.0629	6 1156	37 4007	(66)
SPAC	3.	9 CM SPACING	3780.1521	43.9553	7.3527	54 0625	(86
MTR	1	MONOCULTURE	818 7642	45.4869	8.1957	67.1693	(18)
MTR	2.	MIXTURE	2961.3878	43.5498	7.1237	50 7468	(68)
CUL	3	PARK	3693 6596	29.0839	6.6483	44 1997	(127
SPAC	2	3 CM SPACING	1702.6164	26 1941	5.3693	28.8295	(65)
MTR	1.	MONOCULTURE	282 7976	25.7089	5.5756	31 0878	(11)
MTR	2.	MIXTURE	1419.8188	26.2929	5 3748	28.8885	(54)
SPAC	3.	9 CM SPACING	1991.0432	32 1136	6.5439	42 8223	(62
MTR	1.	MONOCULTURE	431 7666	35.9806	5.9328	35 1983	(12)
MTR	2	MIXTURE	1559 2766	31 1855	6 3927	40 8668	(50)
CUL	4	70M009002	3914 5547	41.6442	7 7543	60 1290	(94)
SPAC	2.	3 CM SPACING	1824 7337	39.6681	7 4411	55 3693	(46)
MTR	1	MONOCULTURE	777 [illegible]	43.1833	7 4792	55 9384	(18)

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CRITERION VARIABLE KH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1047.4333	37.4083	6.5976	43.5281	(28)
SPAC	3.	9 CM SPACING	2089.8216	43.5379	7.6473	58.4811	(48)
MTR	1.	MONOCULTURE	802.3407	44.5745	7.3951	54.6875	(18)
MTR	2.	MIXTURE	1287.4809	42.9160	7.8520	61.6546	(30)
CUL	5.	NORQUAY	3735.8547	38.9152	8.3471	69.6734	(96)
SPAC	2.	3 CM SPACING	1278.8761	35.5243	8.1154	65.8605	(36)
MTR	1.	MONOCULTURE	709.7095	39.4283	7.1517	51.1467	(18)
MTR	2.	MIXTURE	569.1666	31.6204	7.2231	52.1734	(18)
SPAC	3.	9 CM SPACING	2456.9787	40.9496	7.8671	61.8915	(60)
MTR	1.	MONOCULTURE	764.7011	42.4834	9.9170	98.3464	(18)
MTR	2.	MIXTURE	1692.2775	40.2923	6.8418	46.8102	(42)

TOTAL CASES = 570
MISSING CASES = 1 OR 0.2 PCT.

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FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE HI HARVEST INDEX
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

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VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			245.2853	0.4341	0.0482	0.0023	(565)
CUL	1	PITIC 62	36.0719	0.4399	0.0664	0.0044	(82)
SPAC	2.	3 CM SPACING	21.0045	0.4376	0.0733	0.0054	(48)
MTR	2	MIXTURE	21.0045	0.4376	0.0733	0.0054	(48)
SPAC	3	9 CM SPACING	15.0674	0.4432	0.0563	0.0032	(34)
MTR	2.	MIXTURE	15.0674	0.4432	0.0563	0.0032	(34)
CUL	2	GLENLEA	73.1100	0.4352	0.0402	0.0016	(168)
SPAC	2	3 CM SPACING	36.5845	0.4408	0.0412	0.0017	(83)
MTR	1.	MONOCULTURE	7.6676	0.4510	0.0590	0.0035	(17)
MTR	2	MIXTURE	28.9169	0.4381	0.0353	0.0012	(66)
SPAC	3	9 CM SPACING	36.5255	0.4297	0.0387	0.0015	(85)
MTR	1.	MONOCULTURE	7.3348	0.4075	0.0521	0.0027	(18)
MTR	2.	MIXTURE	29.1907	0.4357	0.0322	0.0010	(67)
CUL	3	PARK	51.4721	0.4053	0.0431	0.0019	(127)
SPAC	2.	3 CM SPACING	25.9263	0.3989	0.0397	0.0016	(65)
MTR	1.	MONOCULTURE	4.7664	0.3972	0.0640	0.0041	(12)
MTR	2	MIXTURE	21.1599	0.3992	0.0327	0.0011	(53)
SPAC	3	9 CM SPACING	25.5457	0.4120	0.0457	0.0021	(62)
MTR	1.	MONOCULTURE	4.8881	0.4073	0.0278	0.0008	(12)
MTR	2	MIXTURE	20.6577	0.4132	0.0492	0.0024	(50)
CUL	4	70M009002	42.2242	0.4590	0.0356	0.0013	(92)
SPAC	2.	3 CM SPACING	19.8648	0.4515	0.0350	0.0012	(44)
MTR	1.	MONOCULTURE	7.1809	0.4488	0.0444	0.0020	(16)

CRITERION VARIABLE HI

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	12.6838	0.4530	0.0290	0.0008	(28)
SPAC	3.	9 CM SPACING	22.3594	0.4658	0.0352	0.0012	(48)
MTR	1.	MONOCULTURE	8.1407	0.4523	0.0319	0.0010	(18)
MTR	2.	MIXTURE	14.2187	0.4740	0.0351	0.0012	(30)
CUL	5.	NORQUAY	42.4071	0.4417	0.0416	0.0017	(96)
SPAC	2.	3 CM SPACING	15.7377	0.4372	0.0453	0.0021	(36)
MTR	1.	MONOCULTURE	8.0308	0.4462	0.0425	0.0018	(18)
MTR	2.	MIXTURE	7.7068	0.4282	0.0474	0.0022	(18)
SPAC	3.	9 CM SPACING	26.6694	0.4445	0.0393	0.0015	(60)
MTR	1.	MONOCULTURE	8.0837	0.4491	0.0367	0.0013	(18)
MTR	2.	MIXTURE	18.5857	0.4425	0.0407	0.0017	(42)

TOTAL CASES = 570
MISSING CASES = 5 OR 0.9 PCT.

FILE SPMERG (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - - -

CRITERION VARIABLE B HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			30120.0000	52.8421	10.2666	105.4021	(570)
CUL	1	PITIC 62	4338.0000	52.9024	7.2972	53.2496	(82)
SPAC	2.	3 CM SPACING	2591.0000	53.9792	7.4419	55.3825	(48)
MTR	2	MIXTURE	2591.0000	53.9792	7.4419	55.3825	(48)
SPAC	3	5 CM SPACING	1747.0000	51.3824	6.9108	47.7585	(34)
MTR	2.	MIXTURE	1747.0000	51.3824	6.9108	47.7585	(34)
CUL	2	GLENLEA	10651.0000	62.6529	7.7347	59.8256	(170)
SPAC	2	3 CM SPACING	5489.0000	65.3452	6.5703	43.1685	(84)
MTR	1	MONOCULTURE	1240.0000	68.8889	6.6676	44.4575	(18)
MTR	2	MIXTURE	4249.0000	64.3788	6.2506	39.0697	(66)
SPAC	3.	9 CM SPACING	5162.0000	60.0233	7.9142	62.6347	(86)
MTR	1	MONOCULTURE	1077.0000	59.8333	8.0968	65.5588	(18)
MTR	2	MIXTURE	4085.0000	60.0735	7.9256	62.8154	(68)
CUL	3	PARK	6716.0000	52.4688	8.2614	68.2510	(128)
SPAC	2.	3 CM SPACING	3557.0000	53.8939	7.9636	63.4193	(66)
MTR	1	MONOCULTURE	651.0000	54.2500	10.1366	102.7500	(12)
MTR	2	MIXTURE	2906.0000	53.8148	7.5112	56.4179	(54)
SPAC	3.	9 CM SPACING	3159.0000	50.9516	8.3655	69.9812	(62)
MTR	1.	MONOCULTURE	619.0000	51.5833	7.3541	54.0833	(12)
MTR	2.	MIXTURE	2540.0000	50.8000	8.6520	74.8571	(50)
CUL	4	70M009002	4286.0000	45.5957	5.8775	34.5445	(94)
SPAC	2.	3 CM SPACING	2117.0000	46.0217	6.6583	44.3329	(46)
MTR	1.	MONOCULTURE	833.0000	46.2778	6.5152	42.4477	(18)

CRITERION VARIABLE B

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1284.0000	45.8571	6.8622	47.0899	(28)
SPAC	3.	9 CM SPACING	2169.0000	45.1875	5.0557	25.5598	(48)
MTR	1.	MONOCULTURE	814.0000	45.2222	4.1946	17.5948	(18)
MTR	2.	MIXTURE	1355.0000	45.1667	5.5776	31.1092	(30)
CUL	5.	NORQUAY	4129.0000	43.0104	5.6875	32.3473	(96)
SPAC	2.	3 CM SPACING	1550.0000	43.0556	6.5594	43.0254	(36)
MTR	1.	MONOCULTURE	777.0000	43.1667	7.1146	50.6176	(18)
MTR	2.	MIXTURE	773.0000	42.9444	6.1594	37.9379	(18)
SPAC	3.	9 CM SPACING	2579.0000	42.9833	5.1535	26.5590	(60)
MTR	1.	MONOCULTURE	784.0000	43.5556	6.4464	41.5556	(18)
MTR	2.	MIXTURE	1795.0000	42.7381	4.5589	20.7834	(42)

TOTAL CASES = 570

FILE SPMERG (CREATION DATE = 12/30/81)

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CRITERION VARIABLE D PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			47404.0000	83.1649	13.0110	169 2873	(570)
CUL	1.	PITIC 62	6472.0000	78.9268	8.9770	80.5872	(82)
SPAC	2.	3 CM SPACING	3789.0000	78.9375	9.3340	87 1237	(48)
MTR	2.	MIXTURE	3789.0000	78.9375	9.3340	87 1237	(48)
SPAC	3.	9 CM SPACING	2683.0000	78.9118	8.5860	73 7193	(34)
MTR	2.	MIXTURE	2683.0000	78.9118	8.5860	73 7193	(34)
CUL	2.	GLENLEA	16004 0000	94.1412	8.9113	79 4119	(170)
SPAC	2.	3 CM SPACING	7985.0000	95.0595	7 4742	55 8639	(84)
MTR	1.	MONOCULTURE	1691.0000	93.9444	7.7950	60 7614	(18)
MTR	2.	MIXTURE	6294.0000	95.3636	7.4165	55.0042	(66)
SPAC	3.	9 CM SPACING	8019.0000	93.2442	10.0843	101.6926	(86)
MTR	1.	MONOCULTURE	1680.0000	93.3333	10.5830	112.0000	(18)
MTR	2.	MIXTURE	6339.0000	93.2206	10.0296	100 5924	(68)
CUL	3.	PARK	11379.0000	88.8984	11.2641	126.8794	(128)
SPAC	2.	3 CM SPACING	5871.0000	88.9545	12.5151	156.6287	(66)
MTR	1.	MONOCULTURE	1055.0000	87.9167	20.2550	410.2652	(12)
MTR	2.	MIXTURE	4816.0000	89.1852	10 3269	106 6443	(54)
SPAC	3.	9 CM SPACING	5508.0000	88.8387	9.8617	97.2522	(62)
MTR	1.	MONOCULTURE	1118.0000	93.1667	7.9067	62.5152	(12)
MTR	2.	MIXTURE	4390.0000	87.8000	10.0671	101.3469	(50)
CUL	4.	70M009002	6636.0000	70.5957	6.9349	48 0929	(94)
SPAC	2.	3 CM SPACING	3217.0000	69.9348	8.2392	67.8845	(46)
MTR	1.	MONOCULTURE	1313.0000	72.9444	7.0899	50 4085	(18)

CRITERION VARIABLE D

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	1904.0000	68.0000	8.4547	71.4815	(28)
SPAC	3.	9 CM SPACING	3419.0000	71.2292	5.4157	29.3293	(48)
MTR	1.	MONOCULTURE	1301.0000	72.2778	5.3005	28.0948	(18)
MTR	2.	MIXTURE	2118.0000	70.6000	5.4747	29.9724	(30)
CUL	5.	NORQUAY	6913.0000	72.0104	5.4609	29.8209	(96)
SPAC	2.	3 CM SPACING	2594.0000	72.0556	5.9854	35.8254	(36)
MTR	1.	MONOCULTURE	1322.0000	73.4444	5.6488	31.9085	(18)
MTR	2.	MIXTURE	1272.0000	70.6667	6.1453	37.7647	(18)
SPAC	3.	9 CM SPACING	4319.0000	71.9833	5.1732	26.7624	(60)
MTR	1.	MONOCULTURE	1295.0000	71.9444	6.7604	45 7026	(18)
MTR	2.	MIXTURE	3024.0000	72.0000	4.4228	19.5610	(42)

TOTAL CASES = 570

FILE SPMERG (CREATION DATE = 12/30/81)

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CRITERION VARIABLE HL HEADLENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			6081.0000	10.6684	2.0684	4.2763	(570)
CUL	1.	PITIC 62	1021.0000	12 4512	1.6190	2 6210	(82)
SPAC	2.	3 CM SPACING	584.0000	12.1667	1.5890	2 5248	(48)
MTR	2.	MIXTURE	584 0000	12.1667	1.5890	2 5248	(48)
SPAC	3.	9 CM SPACING	437.0000	12.8529	1.5980	2 5535	(34)
MTR	2.	MIXTURE	437.0000	12.8529	1.5980	2 5535	(34)
CUL	2.	GLENLEA	1899.0000	11.1706	1.4059	1 9766	(170)
SPAC	2.	3 CM SPACING	908.0000	10.8095	1.3032	1.6982	(84)
MTR	1.	MONOCULTURE	192.0000	10.6667	1.1376	1 2941	(18)
MTR	2.	MIXTURE	716.0000	10.8485	1.3501	1.8228	(66)
SPAC	3.	9 CM SPACING	991.0000	11.5233	1.4202	2 0171	(86)
MTR	1.	MONOCULTURE	210 0000	11.6667	1.5718	2 4706	(18)
MTR	2.	MIXTURE	781.0000	11.4853	1.3875	1.9252	(68)
CUL	3.	PARK	1015.0000	7.9297	1.2049	1 4517	(128)
SPAC	2.	3 CM SPACING	494.0000	7.4848	1.0705	1.1459	(66)
MTR	1.	MONOCULTURE	91.0000	7.5833	0.5149	0.2652	(12)
MTR	2.	MIXTURE	403.0000	7.4630	1.1609	1.3477	(54)
SPAC	3.	9 CM SPACING	521.0000	8.4032	1.1659	1.3593	(62)
MTR	1.	MONOCULTURE	110.0000	9.1667	0.7177	0 5152	(12)
MTR	2.	MIXTURE	411.0000	8.2200	1.1830	1.3996	(50)
CUL	4.	70M009002	1071.0000	11.3936	1.6212	2 6283	(94)
SPAC	2.	3 CM SPACING	526.000	11.4348	1.7594	3 0957	(46)
MTR	1.	MONOCULTURE	216.000	12.0000	1.7150	2.9412	(18)

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CRITERION VARIABLE HL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	310.0000	11.0714	1.7198	2.9577	(28)
SPAC	3.	9 CM SPACING	545.0000	11.3542	1.4945	2.2336	(48)
MTR	1.	MONOCULTURE	218.0000	12.1111	1.4507	2.1046	(18)
MTR	2.	MIXTURE	327.0000	10.9000	1.3481	1.8172	(30)
CUL	5.	NORQUAY	1075.0000	11.1979	1.1203	1.2552	(96)
SPAC	2.	3 CM SPACING	394.0000	10.9444	1.0940	1.1968	(36)
MTR	1.	MONOCULTURE	207.0000	11.5000	0.7071	0.5000	(18)
MTR	2.	MIXTURE	187.0000	10.3889	1.1448	1.3105	(18)
SPAC	3.	9 CM SPACING	681.0000	11.3500	1.1173	1.2483	(60)
MTR	1.	MONOCULTURE	205.0000	11.3889	1.1950	1.4281	(18)
MTR	2.	MIXTURE	476.0000	11.3333	1.0969	1.2033	(42)

TOTAL CASES = 570

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FILE SPMERG (CREATION DATE = 12/30/81)

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CRITERION VARIABLE EL EXTRUSION LENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			23365.0000	40.9912	6.9298	48.0228	(570)
CUL	1.	PITIC 62	3155.0000	38.4756	7.1651	51.3389	(82)
SPAC	2.	3 CM SPACING	1782.0000	37.1250	8.1178	65.8989	(48)
MTR	2.	MIXTURE	1782.0000	37.1250	8.1178	65.8989	(48)
SPAC	3.	9 CM SPACING	1373.0000	40.3824	5.0753	25.7585	(34)
MTR	2.	MIXTURE	1373.0000	40.3824	5.0753	25.7585	(34)
CUL	2.	GLENLEA	7252.0000	42.6588	6.4763	41.9421	(170)
SPAC	2.	3 CM SPACING	3404.0000	40.5238	6.6359	44.0356	(84)
MTR	1.	MONOCULTURE	643.0000	35.7222	5.0504	25.5065	(18)
MTR	2.	MIXTURE	2761.0000	41.8333	6.4369	41.4333	(66)
SPAC	3.	9 CM SPACING	3848.0000	44.7442	5.6113	31.4867	(86)
MTR	1.	MONOCULTURE	813.0000	45.1667	6.3916	40.8529	(18)
MTR	2.	MIXTURE	3035.0000	44.6324	5.4332	29.5195	(68)
CUL	3.	PARK	5678.0000	44.3594	7.6083	57.8856	(128)
SPAC	2.	3 CM SPACING	2808.0000	42.5455	8.4274	71.0210	(66)
MTR	1.	MONOCULTURE	495.0000	41.2500	12.3371	152.2045	(12)
MTR	2.	MIXTURE	2313.0000	42.8333	7.4194	55.0472	(54)
SPAC	3.	9 CM SPACING	2870.0000	46.2903	6.1228	37.4881	(62)
MTR	1.	MONOCULTURE	609.0000	50.7500	5.0295	25.2955	(12)
MTR	2.	MIXTURE	2261.0000	45.2200	5.9119	34.9506	(50)
CUL	4.	70M009002	3421.0000	36.3936	5.2532	27.5961	(94)
SPAC	2.	3 CM SPACING	1626.0000	35.3478	6.0119	36.1430	(46)
MTR	1.	MONOCULTURE	696.0000	38.6667	6.0391	36.4706	(18)

CRITERION VARIABLE EL

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	930.0000	33.2143	5.0211	25.2116	(28)
SPAC	3.	9 CM SPACING	1795.0000	37.3958	4.2313	17.9038	(48)
MTR	1.	MONOCULTURE	705.0000	39.1667	4.2737	18.2647	(18)
MTR	2.	MIXTURE	1090.0000	36.3333	3.8981	15.1954	(30)
CUL	5.	NORQUAY	3859.0000	40.1979	4.1918	17.5709	(96)
SPAC	2.	3 CM SPACING	1438.0000	39.9444	4.6164	21.3111	(36)
MTR	1.	MONOCULTURE	752.0000	41.7778	4.2503	18.0654	(18)
MTR	2.	MIXTURE	686.0000	38.1111	4.3235	18.6928	(18)
SPAC	3.	9 CM SPACING	2421.0000	40.3500	3.9481	15.5873	(60)
MTR	1.	MONOCULTURE	716.0000	39.7778	4.3731	19.1242	(18)
MTR	2.	MIXTURE	1705.0000	40.5952	3.7810	14.2956	(42)

TOTAL CASES = 570

FILE SPMERG (CREATION DATE = 12/30/81)

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CRITERION VARIABLE YH SEED YIELD PER HEAD G
BROKEN DOWN BY CUL CULTIVAR
BY SPAC INTER-PLANT SPACING
BY MTR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			907.9368	1.5929	0.5386	0.2901	(570)
CUL	1.	PITIC 62	134.9181	1.6453	0.4502	0.2027	(82)
SPAC	2.	3 CM SPACING	73.6814	1.5350	0.4930	0.2430	(48)
MTR	2	MIXTURE	73.6814	1.5350	0.4930	0.2430	(48)
SPAC	3.	9 CM SPACING	61.2367	1.8011	0.3297	0.1087	(34)
MTR	2.	MIXTURE	61.2367	1.8011	0.3297	0.1087	(34)
CUL	2.	GLENLEA	346.1963	2.0364	0.4619	0.2134	(170)
SPAC	2.	3 CM SPACING	156.9266	1.8682	0.4120	0.1697	(84)
MTR	1.	MONOCULTURE	31.3333	1.7407	0.6045	0.3655	(18)
MTR	2.	MIXTURE	125.5933	1.9029	0.3397	0.1154	(66)
SPAC	3.	9 CM SPACING	189.2698	2.2008	0.4508	0.2032	(86)
MTR	1.	MONOCULTURE	40.7857	2.2659	0.4825	0.2328	(18)
MTR	2.	MIXTURE	148.4841	2.1836	0.4442	0.1973	(68)
CUL	3.	PARK	129.3770	1.0108	0.2962	0.0878	(128)
SPAC	2.	3 CM SPACING	58.6557	0.8887	0.2419	0.0585	(66)
MTR	1.	MONOCULTURE	10.1998	0.8500	0.3385	0.1146	(12)
MTR	2.	MIXTURE	48.4559	0.8973	0.2181	0.0476	(54)
SPAC	3.	9 CM SPACING	70.7214	1.1407	0.2951	0.0871	(62)
MTR	1.	MONOCULTURE	15.5596	1.2966	0.2215	0.0491	(12)
MTR	2.	MIXTURE	55.1618	1.1032	0.3000	0.0900	(50)
CUL	4.	70M009002	150.1081	1.5969	0.3605	0.1300	(94)
SPAC	2.	3 CM SPACING	66.7416	1.4509	0.3401	0.1156	(46)
MTR	1.	MONOCULTURE	29.1383	1.6188	0.3251	0.1057	(18)

CRITERION VARIABLE YH

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
MTR	2.	MIXTURE	37.6033	1.3430	0.3087	0.0953	(28)
SPAC	3.	9 CM SPACING	83.3665	1.7368	0.3250	0.1056	(48)
MTR	1.	MONOCULTURE	32.9680	1.8316	0.3200	0.1024	(18)
MTR	2.	MIXTURE	50.3984	1.6799	0.3197	0.1022	(30)
CUL	5.	NORQUAY	147.3372	1.5348	0.3549	0.1259	(96)
SPAC	2.	3 CM SPACING	50.6419	1.4067	0.3657	0.1338	(36)
MTR	1.	MONOCULTURE	28.5902	1.5883	0.3107	0.0966	(18)
MTR	2	MIXTURE	22.0517	1.2251	0.3301	0.1090	(18)
SPAC	3.	9 CM SPACING	96.6953	1.6116	0 3277	0.1074	(60)
MTR	1.	MONOCULTURE	30.1402	1.6745	0.3936	0.1549	(18)
MTR	2.	MIXTURE	66.5551	1.5846	0.2964	0.0879	(42)

TOTAL CASES = 570

Appendix 8. Distribution parameters of characters of single plants, grown in monoculture and in mixture, at two interplant spacings.

All plants were grown in four-row plots in 1978. The data are from randomly selected plants, which had both neighbours present, and which were harvested at maturity.

Character[1]	Spacing (cm)	Skewness[2,3] Monoculture	Skewness[2,3] Mixture	Kurtosis[3] Monoculture	Kurtosis[3] Mixture
T	3	0.47	0.88**	1.21	1.66**
H	3	0.53	0.40*	1.02	0.60
Wt	3	0.72*	0.38*	1.44*	0.78*
Y	3	0.91**	0.43*	0.71	0.42
K/P	3	0.59	0.47*	0.97	0.40
Kwt	3	0.54	-0.88**	3.41**	2.18**
K/H	3	0.90**	-0.16	1.53	0.52
HI	3	-0.09	-0.64**	5.99**	1.51**
FL	3	-0.82**	-0.29	0.87	0.57
Ht	3	-1.15**	-0.86**	1.57*	1.29**
ExL	3	0.40	-0.54**	1.51*	-0.13
HL	3	0.33	-0.40	0.65	0.93
T	9	0.20	0.63**	-0.48	0.49
H	9	-0.09	0.72**	-0.75	0.93*
Wt	9	0.12	0.29	-0.13	0.03
Y	9	-0.15	0.32	-0.46	0.12
K/P	9	-0.03	0.47*	-0.51	0.31
Kwt	9	-0.16	-1.36**	-0.02	3.40**
K/H	9	-0.34	-0.09	1.86**	0.04
HI	9	-1.46**	-0.89**	3.10**	2.64**
FL	9	0.33	0.31	-0.23	-0.16
Ht	9	-0.93**	0.07	1.24*	-0.08
ExL	9	-0.53	-0.37	0.52	-0.12
HL	9	-0.28	-0.41	0.33	0.58

1. Character abbreviations defined in Table 1, HL = Head Length.
2. Values of skewness and kurtosis are averages of four genotypes and three replicates.
3. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

Appendix 9. Relative Yield Totals[1] for several characters of plants grown in mixtures at two interplant spacings in 1978.

Mixture	Character[2]															
	Y		T		H		Kwt		HI		Wt		K/H		Y/H	
	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm	3 cm	9 cm
+ Park	0.94	1.13	1.03	1.15	0.97	1.25*	1.00	0.97	0.97	1.03	0.96	1.08	0.97	0.87	0.99	0.85**
70M009002	0.98	1.01	1.02	1.08	1.04	1.11	0.99	0.99	1.00	1.04	0.97	0.98	0.95	0.92	0.94	0.91
lea + Norquay	0.88	1.12	0.99	1.12	0.95	1.23*	0.99	0.98	0.97	1.05	1.14	1.08	0.87	0.91	1.00	0.90
Park + 70M009002	0.78*	0.86	0.91	0.83	0.88	0.88	0.96	1.00	0.99	1.03	0.79**	0.84	0.92	0.98	0.92	0.92
Park + Norquay	1.00	0.93	1.11	0.95	1.00	0.97	0.99	1.01	0.99	0.99	0.97	0.98	1.02	0.95	1.05	0.95

1. See Section 6.2.

   * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

2. Character abbreviations defined in Table 1.

Appendix. 10. Descriptive statistics of characters of plants, grown in monoculture and in mixture, in machine seeded plots, measured at the flowering stage, in 1978.

FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE B HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			72272.0000	55.1695	12.2985	151.2532	(1310)
CUL	1	PITIC 62	16839.0000	51.9722	8.3992	70.5472	(324)
COMP	1.	MONOCULTURE	4098.0000	51.2250	7.3329	53.7715	(80)
COMP	2	MIXTURE	12741.0000	52.2172	8.7205	76.0473	(244)
CUL	2	GLENLEA	18378.0000	67.8155	8.4885	72.0547	(271)
COMP	1	MONOCULTURE	4114.0000	68.5667	7.5428	56.8938	(60)
COMP	2	MIXTURE	14264.0000	67.6019	8.7436	76.4503	(211)
CUL	3	PARK	16963.0000	59.3112	13.0639	170.6642	(286)
COMP	1	MONOCULTURE	3232.0000	53.8667	6.4558	41.6768	(60)
COMP	2	MIXTURE	13731.0000	60.7566	13.9729	195.2427	(226)
CUL	4	70M009002	9996.0000	47.6000	7.7677	60.3368	(210)
COMP	1	MONOCULTURE	2779.0000	47.9138	7.6578	58.6416	(58)
COMP	2	MIXTURE	7217.0000	47.4803	7.8310	61.3241	(152)
CUL	5	NORQUAY	10096.0000	46.1005	7.6918	59.1642	(219)
COMP	1	MONOCULTURE	2655.0000	45.0000	7.0613	49.8621	(59)
COMP	2	MIXTURE	7441.0000	46.5062	7.8939	62.3144	(160)

TOTAL CASES = 1310

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE D PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			92380.0000	73.7271	16.4646	271.0836	(1253)
CUL	1.	PITIC 62	20816.0000	64.2469	11.5887	134.2980	(324)
COMP	1.	MONOCULTURE	5142.0000	64.2750	10.9440	119.7715	(80)
COMP	2.	MIXTURE	15674.0000	64.2377	11.8141	139.5729	(244)
CUL	2.	GLENLEA	23130.0000	85.3506	11.8936	141.4581	(271)
COMP	1.	MONOCULTURE	4977.0000	82.9500	12.2037	148.9297	(60)
COMP	2.	MIXTURE	18153.0000	86.0332	11.7438	137.9179	(211)
CUL	3.	PARK	21832.0000	88.0323	15.2384	232.2095	(248)
COMP	1.	MONOCULTURE	5178.0000	86.3000	15.0607	226.8237	(60)
COMP	2.	MIXTURE	16654.0000	88.5851	15.2931	233.8804	(188)
CUL	4.	70M009002	13573.0000	64.6333	11.5375	133.1137	(210)
COMP	1.	MONOCULTURE	3709.0000	63.9483	10.1107	102.2253	(58)
COMP	2.	MIXTURE	9864.0000	64.8947	12.0584	145.4061	(152)
CUL	5.	NORQUAY	13029.0000	65.1450	10.9977	120.9487	(200)
COMP	1.	MONOCULTURE	3859.0000	65.4068	11.7724	138.5903	(59)
COMP	2.	MIXTURE	9170.0000	65.0355	10.6987	114.4630	(141)

TOTAL CASES = 1310
MISSING CASES = 57 OR 4.4 PCT.

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE HL HEADLENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14088.0000	11.2524	2.7777	7.7156	(1252)
CUL	1.	PITIC 62	4158.0000	12.8333	1.5826	2.5046	(324)
COMP	1.	MONOCULTURE	1031.0000	12.8875	1.4495	2.1011	(80)
COMP	2.	MIXTURE	3127.0000	12.8156	1.6263	2.6449	(244)
CUL	2.	GLENLEA	3037.0000	11.2066	2.0785	4.3201	(271)
COMP	1.	MONOCULTURE	668.0000	11.1333	1.8546	3.4395	(60)
COMP	2.	MIXTURE	2369.0000	11.2275	2.1415	4.5861	(211)
CUL	3.	PARK	2038.0000	8.2510	3.5866	12.8636	(247)
COMP	1.	MONOCULTURE	481.0000	8.0167	1.1122	1.2370	(60)
COMP	2.	MIXTURE	1557.0000	8.3262	4.0740	16.5973	(187)
CUL	4.	70M009002	2529.0000	12.0429	1.9376	3.7541	(210)
COMP	1.	MONOCULTURE	702.0000	12.1034	1.8228	3.3224	(58)
COMP	2.	MIXTURE	1827.0000	12.0197	1.9849	3.9400	(152)
CUL	5.	NORQUAY	2326.0000	11.6300	1.6360	2.6765	(200)
COMP	1.	MONOCULTURE	704.0000	11.9322	1.8925	3.5815	(59)
COMP	2.	MIXTURE	1622.0000	11.5035	1.5053	2.2661	(141)

TOTAL CASES = 1310
MISSING CASES = 58 OR 4.4 PCT.

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE EL EXTRUSION LENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			20108.0000	15.3613	21.7945	475.0001	(1309)
CUL	1.	PITIC 62	3977.0000	12.3127	5.1882	26.9174	(323)
COMP	1.	MONOCULTURE	1044.0000	13.0500	5.3389	28.5038	(80)
COMP	2.	MIXTURE	2933.0000	12.0700	5.1256	26.2719	(243)
CUL	2.	GLENLEA	4752.0000	17.5351	9.8612	97.2423	(271)
COMP	1.	MONOCULTURE	863.0000	14.3833	7.6382	58.3421	(60)
COMP	2.	MIXTURE	3889.0000	18.4313	10.2464	104.9893	(211)
CUL	3.	PARK	4869.0000	17.0245	40.5949	1647.9468	(286)
COMP	1.	MONOCULTURE	1946.0000	32.4333	11.5309	132.9616	(60)
COMP	2.	MIXTURE	2923.0000	12.9336	44.4118	1972.4089	(226)
CUL	4.	70M009002	3577.0000	17.0333	6.3248	40.0037	(210)
COMP	1.	MONOCULTURE	930.0000	16.0345	6.2994	39.6830	(58)
COMP	2.	MIXTURE	2647.0000	17.4145	6.3135	39.8602	(152)
CUL	5.	NORQUAY	2933.0000	13.3927	21.6140	467.1662	(219)
COMP	1.	MONOCULTURE	1204.0000	20.4068	6.4704	41.8662	(59)
COMP	2.	MIXTURE	1729.0000	10.8062	24.5002	600.2578	(160)

TOTAL CASES = 1310
MISSING CASES = 1 OR 0.1 PCT.

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE AREA FLAGLEAF BLADE AREA CM SQ.
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			31318.5937	24.1098	8.0618	64.9919	(1299)
CUL	1.	PITIC 62	8735.5982	27.0452	6.7224	45.1912	(323)
COMP	1	MONOCULTURE	2170.6995	27 4772	6.1886	38.2982	(79)
COMP	2.	MIXTURE	6564.8987	26.9053	6 8927	47 5095	(244)
CUL	2.	GLENLEA	7548 0986	27.9559	7.2998	53.2877	(270)
COMP	1.	MONOCULTURE	1646.6997	27.4450	7 4641	55 7123	(60)
COMP	2.	MIXTURE	5901.3989	28 1019	7 2637	52.7618	(210)
CUL	3.	PARK	4921.5990	17 7675	8.1315	66 1207	(277)
COMP	1.	MONOCULTURE	1006.2998	16.7717	6 5459	42.8492	(60)
COMP	2.	MIXTURE	3915.2992	18.0429	8.5107	72.4318	(217)
CUL	4.	70M009002	4640.1990	22.0962	6.6444	44.1478	(210)
COMP	1.	MONOCULTURE	1348.9997	23.2586	7.2015	51.8621	(58)
COMP	2.	MIXTURE	3291.1993	21.6526	6.3884	40.8111	(152)
CUL	5.	NORQUAY	5473.0988	24.9913	6.4453	41.5424	(219)
COMP	1.	MONOCULTURE	1485.7997	25.1830	5.4011	29 1721	(59)
COMP	2.	MIXTURE	3987 2992	24.9206	6.8042	46.2975	(160)

TOTAL CASES = 1310
MISSING CASES = 11 OR 0.8 PCT.

Appendix 11. Descriptive statistics of characters of plants, grown in monoculture and in mixture, in machine seeded plots, measured at the middough stage, in 1978.

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE B HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			69030.0000	54.3972	11.5226	132.7712	(1269)
CUL	1.	PITIC 62	15059.0000	52.2882	8.4822	71.9480	(288)
COMP	1.	MONOCULTURE	3139.0000	52.3167	9.2763	86.0506	(60)
COMP	2.	MIXTURE	11920.0000	52.2807	8.2825	68.5993	(228)
CUL	2.	GLENLEA	20114.0000	66.6026	10.5592	111.4961	(302)
COMP	1.	MONOCULTURE	3645.0000	61.7797	12.3429	152.3472	(59)
COMP	2.	MIXTURE	16469.0000	67.7737	9.7528	95.1180	(243)
CUL	3.	PARK	14537.0000	55.0644	9.0814	82.4711	(264)
COMP	1.	MONOCULTURE	2049.0000	51.2250	8.0208	64.3327	(40)
COMP	2.	MIXTURE	12488.0000	55.7500	9.1048	82.8969	(224)
CUL	4.	70M009002	10556.0000	47.7647	7.1433	51.0262	(221)
COMP	1.	MONOCULTURE	2831.0000	47.1833	6.9367	48.1184	(60)
COMP	2.	MIXTURE	7725.0000	47.9814	7.2280	52.2434	(161)
CUL	5.	NORQUAY	8764.0000	45.1753	6.6831	44.6634	(194)
COMP	1.	MONOCULTURE	2545.0000	43.8793	7.7891	60.6694	(58)
COMP	2.	MIXTURE	6219.0000	45.7279	6.0997	37.2069	(136)

TOTAL CASES = 1269

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FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE D PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			108206.0000	85.2687	14.7755	218.3150	(1269)
CUL	1.	PITIC 62	23322.0000	80.9792	10.8058	116.7661	(288)
COMP	1.	MONOCULTURE	4872.0000	81.2000	11.2292	126.0949	(60)
COMP	2	MIXTURE	18450.0000	80.9211	10.7163	114.8396	(228)
CUL	2.	GLENLEA	29689.0000	98.3079	13.0919	171.3965	(302)
COMP	1.	MONOCULTURE	5559.0000	94.2203	13.9148	193.6230	(59)
COMP	2.	MIXTURE	24130.0000	99.3004	12.7167	161.7152	(243)
CUL	3.	PARK	24249.0000	91.8523	12.7320	162.1036	(264)
COMP	1.	MONOCULTURE	3536.0000	88.4000	14.1363	199.8359	(40)
COMP	2.	MIXTURE	20713.0000	92.4688	12.3981	153.7120	(224)
CUL	4.	70M009002	16494.0000	74.6335	8.5268	72.7060	(221)
COMP	1.	MONOCULTURE	4493.0000	74.8833	9.4027	88.4099	(60)
COMP	2.	MIXTURE	12001.0000	74.5404	8.2059	67.3374	(161)
CUL	5.	NORQUAY	14452.0000	74.4948	9.5191	90.6140	(194)
COMP	1.	MONOCULTURE	4328.0000	74.6207	11.0562	122.2396	(58)
COMP	2.	MIXTURE	10124.0000	74.4412	8.8274	77.9224	(136)

TOTAL CASES = 1269

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FILE FLAGMERG (CREATION DATE = 03/16/82)

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE HL HEADLENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			14308.0000	11.2758	2.5255	6.3781	(1269)
CUL	1.	PITIC 62	3826.0000	13.2847	2.2513	5.0685	(288)
COMP	1.	MONOCULTURE	802.0000	13.3667	1.5290	2.3379	(60)
COMP	2.	MIXTURE	3024.0000	13.2632	2.4080	5.7983	(228)
CUL	2.	GLENLEA	3335.0000	11.0430	1.7005	2.8918	(302)
COMP	1.	MONOCULTURE	588.0000	9.9661	2.1812	4.7575	(59)
COMP	2.	MIXTURE	2747.0000	11.3045	1.4509	2.1052	(243)
CUL	3.	PARK	2147.0000	8.1326	1.0968	1.2029	(264)
COMP	1.	MONOCULTURE	307.0000	7.6750	1.1851	1.4045	(40)
COMP	2.	MIXTURE	1840.0000	8.2143	1.0624	1.1288	(224)
CUL	4.	70M009002	2748.0000	12.4344	1.9286	3.7195	(221)
COMP	1.	MONOCULTURE	777.0000	12.9500	1.9951	3.9805	(60)
COMP	2.	MIXTURE	1971.0000	12.2422	1.8734	3.5097	(161)
CUL	5.	NORQUAY	2253.0000	11.6134	1.6446	2.7047	(194)
COMP	1.	MONOCULTURE	665.0000	11.4655	1.6985	2.8848	(58)
COMP	2.	MIXTURE	1588.0000	11.6765	1.6234	2.6353	(136)

TOTAL CASES = 1269

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FILE FLAGMERG (CREATION DATE = 03/16/82)

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE EL EXTRUSION LENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			39176.0000	30.9203	7.6249	58.1398	(1267)
CUL	1.	PITIC 62	8263.0000	28.6910	5.5954	31.3084	(288)
COMP	1.	MONOCULTURE	1733.0000	28.8833	4.9200	24.2065	(60)
COMP	2.	MIXTURE	6530.0000	28.6404	5.7689	33.2798	(228)
CUL	2.	GLENLEA	9575.0000	31.8106	7.6403	58.3740	(301)
COMP	1.	MONOCULTURE	1914.0000	32.4407	8.2321	67.7680	(59)
COMP	2.	MIXTURE	7661.0000	31.6570	7.4990	56.2346	(242)
CUL	3.	PARK	9712.0000	36.7879	8.8572	78.4491	(264)
COMP	1.	MONOCULTURE	1487.0000	37.1750	8.9811	80.6609	(40)
COMP	2.	MIXTURE	8225.0000	36.7188	8.8534	78.3824	(224)
CUL	4.	70M009002	5938 0000	26.8688	5.2808	27.8872	(221)
COMP	1.	MONOCULTURE	1662.0000	27 7000	5.4998	30.2475	(60)
COMP	2.	MIXTURE	4276.0000	26.5590	5.1803	26.8356	(161)
CUL	5.	NORQUAY	5688.0000	29.4715	5.3755	28.8963	(193)
COMP	1.	MONOCULTURE	1783.0000	30.7414	6.2283	38.7916	(58)
COMP	2.	MIXTURE	3905.0000	28.9259	4.8893	23.9049	(135)

TOTAL CASES = 1269
MISSING CASES = 2 OR 0.2 PCT.

FILE FLAGMERG (CREATION DATE = 03/16/82)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE AREA FLAGLEAF BLADE AREA CM SQ.
BROKEN DOWN BY CUL CULTIVAR
BY COMP TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			34578.1930	27.4866	9.1063	82.9240	(1258)
CUL	1.	PITIC 62	8679.1983	30.2411	7.7647	60.2911	(287)
COMP	1.	MONOCULTURE	1798.3996	29.9733	6.6212	43.8400	(60)
COMP	2.	MIXTURE	6880.7987	30.3119	8.0516	64.8286	(227)
CUL	2.	GLENLEA	9911.8983	33.0397	9.8973	97 9566	(300)
COMP	1.	MONOCULTURE	1720.1997	29.1559	11.6518	135.7656	(59)
COMP	2.	MIXTURE	8191.6986	33.9905	9.1985	84.6118	(241)
CUL	3.	PARK	4965.7988	19.3977	5.9636	35.5648	(256)
COMP	1.	MONOCULTURE	661.3999	16.5350	5.4182	29.3572	(40)
COMP	2.	MIXTURE	4304.3990	19.9278	5.9202	35.0493	(216)
CUL	4.	70M009002	5754.8987	26.0403	7.4861	56.0414	(221)
COMP	1.	MONOCULTURE	1721.2996	28.6883	7.0428	49 6017	(60)
COMP	2.	MIXTURE	4033.5991	25.0534	7.4268	55.1567	(161)
CUL	5.	NORQUAY	5266.3988	27.1464	6.2923	39.5930	(194)
COMP	1	MONOCULTURE	1635.8997	28.2052	6 9118	47.7731	(58)
COMP	2.	MIXTURE	3630 4992	26.6948	5.9787	35 7454	(136)

TOTAL CASES = 1269
MISSING CASES = 11 OR 0.9 PCT.

Appendix 12. Variation in thousand kernel weights (g) among the seed classes used in 1979.

Genotype	Seed class		
	Small	Large	Unsorted[1]
Pitic 62	29.8	40.8	---[2]
Glenlea	32.0	45.6	44.5
Park	25.8	36.0	34.9
70M009002	25.6	46.2	45.9
Norquay	25.5	38.0	37.3

1 Only sorted small and large seeds were used in the seed size experiment.

2 No data available.

Appendix 13. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at the 3-5 leaf stage, in 1979.

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FILE SDL1 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE HT1 PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			8602.5000	17.8475	[illegible] 7551	14.1009	(482)
CUL	0		1780 5000	17 1202	3 0173	9.1043	(104)
TR	1	LARGE SEED	749 0000	17 8333	3.1693	10 0447	(42
TR	2	SMALL SEED	625 0000	17 3611	2 7376	7 4944	(36)
TR	3	MIXED SEED	406 5000	15 6346	2 7039	7.3112	(26
CUL	1	PITIC 62	1850 5000	17 6238	2 8536	8.1432	105)
TR	1	LARGE SEED	689 0000	18 1316	1.9406	3 7660	(38)
TR	2	SMALL SEED	575 0000	16 9118	3.0932	9 5677	(34)
TR	3	MIXED SEED	586.5000	17.7727	3.3729	11.3764	(33)
CUL	2	GLENLEA	2128 0000	19 1712	3 1855	10 1477	(111)
TR	1	LARGE SEED	746 0000	19 6316	3 8742	15 0092	(38)
TR	2	SMALL SEED	746 5000	19 6447	3.0732	9 4447	(38)
TR	3	MIXED SEED	635.5000	18 1571	2.1617	4 6731	(35)
CUL	3	PARK	1879 5000	19 1786	4 4509	19.8106	(98)
TR	1	LARGE SEED	615 0000	18 6364	4 6742	21.8480	(33)
TR	2	SMALL SEED	605 5000	19 5323	5.4190	29 3656	(31)
TR	3.	MIXED SEED	659 0000	19.3824	3 1456	9.8948	(34)
CUL	4	70M009002	964.0000	15 0625	4 0537	16 4325	(64)
TR	1	LARGE SEED	351 0000	15 2609	3.9996	15 9970	(23)
TR	2	SMALL SEED	225 0000	14 0625	3 7854	14.3292	(16)
TR	3	MIXED SEED	388 0000	15 5200	4 3120	18 5933	(25

TOTAL CASES = 482

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FILE SDL1 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE L1 NUMBER OF LEAVES
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1762.0000	3.6556	0.6745	0.4549	(482)
CUL	0.		397.0000	3.8173	0.4978	0.2479	(104)
TR	1.	LARGE SEED	156.0000	3.7143	0.5962	0.3554	(42)
TR	2.	SMALL SEED	140.0000	3.8889	0.3984	0.1587	(36)
TR	3.	MIXED SEED	101.0000	3.8846	0.4315	0.1862	(26)
CUL	1.	PITIC 62	384.0000	3.6571	0.6175	0.3813	(105)
TR	1.	LARGE SEED	126.0000	3.3158	0.4711	0.2219	(38)
TR	2.	SMALL SEED	128.0000	3.7647	0.6989	0.4884	(34)
TR	3.	MIXED SEED	130.0000	3.9394	0.4962	0.2462	(33)
CUL	2.	GLENLEA	401.0000	3.6126	0.6204	0.3849	(111)
TR	1.	LARGE SEED	140.0000	3.6842	0.6619	0.4381	(38)
TR	2.	SMALL SEED	128.0000	3.3684	0.6334	0.4011	(38)
TR	3.	MIXED SEED	133.0000	3.8000	0.4728	0.2235	(35)
CUL	3.	PARK	348.0000	3.5510	0.7615	0.5798	(98)
TR	1.	LARGE SEED	120.0000	3.6364	0.7424	0.5511	(33)
TR	2.	SMALL SEED	111.0000	3.5806	0.8860	0.7849	(31)
TR	3.	MIXED SEED	117.0000	3.4412	0.6602	0.4358	(34)
CUL	4.	70M009002	232.0000	3.6250	0.8997	0.8095	(64)
TR	1.	LARGE SEED	88.0000	3.8261	1.1140	1.2411	(23)
TR	2.	SMALL SEED	56.0000	3.5000	0.6325	0.4000	(16)
TR	3.	MIXED SEED	88.0000	3.5200	0.8226	0.6767	(25)

TOTAL CASES = 482

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FILE SDL1 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE T1 TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			921.0000	1.9108	0.8949	0.8008	(482)
CUL	0.		223.0000	2.1442	0.8175	0.6683	(104)
TR	1.	LARGE SEED	100.0000	2.3810	0.9094	0.8269	(42)
TR	2.	SMALL SEED	70.0000	1.9444	0.7908	0.6254	(36)
TR	3.	MIXED SEED	53.0000	2.0385	0.5987	0.3585	(26)
CUL	1.	PITIC 62	223.0000	2.1238	0.8955	0.8018	(105)
TR	1.	LARGE SEED	86.0000	2.2632	0.7947	0.6316	(38)
TR	2.	SMALL SEED	68.0000	2.0000	0.9211	0.8485	(34)
TR	3.	MIXED SEED	69.0000	2.0909	0.9799	0.9602	(33)
CUL	2.	GLENLEA	176.0000	1.5856	0.7195	0.5176	(111)
TR	1.	LARGE SEED	57.0000	1.5000	0.7260	0.5270	(38)
TR	2.	SMALL SEED	63.0000	1.6579	0.8146	0.6636	(38)
TR	3.	MIXED SEED	56.0000	1.6000	0.6039	0.3647	(35)
CUL	3.	PARK	166.0000	1.6939	0.6797	0.4620	(98)
TR	1.	LARGE SEED	55.0000	1.6667	0.5951	0.3542	(33)
TR	2.	SMALL SEED	50.0000	1.6129	0.8437	0.7118	(31)
TR	3.	MIXED SEED	61.0000	1.7941	0.5918	0.3503	(34)
CUL	4.	70M009002	133.0000	2.0781	1.2762	1.6287	(64)
TR	1.	LARGE SEED	61.0000	2.6522	1.4016	1.9644	(23)
TR	2.	SMALL SEED	25.0000	1.5625	0.9639	0.9292	(16)
TR	3.	MIXED SEED	47.0000	1.8800	1.1662	1.3600	(25)

TOTAL CASES = 482

FILE SDL1 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE DW1 DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			44.3170	0.0919	0.0401	0.0016	(482)
CUL	0.		10.6280	0.1022	0.0422	0.0018	(104)
TR	1.	LARGE SEED	4.9930	0.1189	0.0508	0.0026	(42)
TR	2.	SMALL SEED	3.4830	0.0967	0.0324	0.0010	(36)
TR	3.	MIXED SEED	2.1520	0.0828	0.0272	0.0007	(26)
CUL	1.	PITIC 62	9.3420	0.0890	0.0335	0.0011	(105)
TR	1	LARGE SEED	3.5570	0.0936	0.0312	0.0010	(38)
TR	2.	SMALL SEED	2.8060	0.0825	0.0366	0.0013	(34)
TR	3.	MIXED SEED	2.9790	0.0903	0.0325	0.0011	(33)
CUL	2.	GLENLEA	10.9970	0.0991	0.0381	0.0015	(111)
TR	1.	LARGE SEED	3.8340	0.1009	0.0442	0.0020	(38)
TR	2.	SMALL SEED	3.8000	0.1000	0.0328	0.0011	(38)
TR	3.	MIXED SEED	3.3630	0.0961	0.0373	0.0014	(35)
CUL	3.	PARK	8.0460	0.0821	0.0354	0.0013	(98)
TR	1.	LARGE SEED	2.5860	0.0784	0.0319	0.0010	(33)
TR	2.	SMALL SEED	2.6340	0.0850	0.0418	0.0018	(31)
TR	3.	MIXED SEED	2.8260	0.0831	0.0329	0.0011	(34)
CUL	4.	70M009002	5.3040	0.0829	0.0506	0.0026	(64)
TR	1.	LARGE SEED	2.2680	0.0986	0.0579	0.0034	(23)
TR	2.	SMALL SEED	0.8710	0.0544	0.0333	0.0011	(16)
TR	3.	MIXED SEED	2.1650	0.0866	0.0464	0.0022	(25)

TOTAL CASES = 482

Appendix 14. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at the jointing stage, in 1979.

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FILE SDL2 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE HT1 PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3880.5000	9.5344	4.8401	23.4264	(407)
CUL	0.		826.0000	8.6042	4.9884	24.8838	(96)
TR	1.	LARGE SEED	343.5000	8.8077	4.9479	24.4818	(39)
TR	2.	SMALL SEED	277.0000	8.1471	4.3875	19.2504	(34)
TR	3.	MIXED SEED	205.5000	8.9348	5.9816	35.7796	(23)
CUL	1.	PITIC 62	399.5000	7.6827	3.9283	15.4317	(52)
TR	1.	LARGE SEED	226.0000	8.0714	3.8938	15.1614	(28)
TR	2.	SMALL SEED	86.0000	6.1429	3.9195	15.3626	(14)
TR	3.	MIXED SEED	87.5000	8.7500	3.7878	14.3472	(10)
CUL	2.	GLENLEA	867.2000	9.2255	5.2869	27.9512	(94)
TR	1.	LARGE SEED	281.8000	7.6162	4.9622	24.6231	(37)
TR	2.	SMALL SEED	247.4000	9.1630	5.5790	31.1247	(27)
TR	3.	MIXED SEED	338.0000	11.2667	4.8525	23.5471	(30)
CUL	3.	PARK	938.5000	10.9128	4.6255	21.3952	(86)
TR	1.	LARGE SEED	349.0000	12.4643	5.3885	29.0357	(28)
TR	2.	SMALL SEED	284.0000	10.1429	4.2771	18.2937	(28)
TR	3.	MIXED SEED	305.5000	10.1833	3.8985	15.1980	(30)
CUL	4.	70MOO9002	849.3000	10.7506	4.2237	17.8395	(79)
TR	1.	LARGE SEED	328.8000	11.7429	4.0515	16.4144	(28)
TR	2.	SMALL SEED	181.0000	9.0500	4.0585	16.4711	(20)
TR	3.	MIXED SEED	339.5000	10.9516	4.2766	18.2892	(31)

TOTAL CASES = 407

APPENDIX 14 03/16/82 PAGE 3

FILE SDL2 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE T1 TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			2241.0000	5.5061	2.0843	4.3442	(407)
CUL	0.		504.0000	5.2500	1.6733	2.8000	(96)
TR	1.	LARGE SEED	205.0000	5.2564	1.3711	1.8799	(39)
TR	2	SMALL SEED	171.0000	5.0294	1.7835	3.1809	(34)
TR	3.	MIXED SEED	128.0000	5.5652	1.9731	3.8933	(23)
CUL	1	PITIC 62	291 0000	5.5962	3.2009	10.2455	(52)
TR	1.	LARGE SEED	148.0000	5.2857	3.3978	11.5450	(28)
TR	2.	SMALL SEED	93 0000	6.6429	2.0232	4 0934	(14)
TR	3	MIXED SEED	50.0000	5 0000	3.8873	15 1111	(10)
CUL	2.	GLENLEA	483.0000	5 1383	1.7996	3.2387	(94)
TR	1	LARGE SEED	174.0000	4.7027	1.6644	2.7703	(37)
TR	2.	SMALL SEED	156.0000	5 7778	2 1543	4.6410	(27)
TR	3.	MIXED SEED	153.0000	5.1000	1.4704	2 1621	(30)
CUL	3.	PARK	489.0000	5.6860	1.8102	3.2767	(86)
TR	1	LARGE SEED	154.0000	5.5000	1.6667	2.7778	(28)
TR	2.	SMALL SEED	159.0000	5.6786	2.1952	4.8188	(28)
TR	3.	MIXED SEED	176.0000	5.8667	1.5698	2.4644	(30)
CUL	4.	70MOO9002	474.0000	6.0000	2.1304	4.5385	(79)
TR	1	LARGE SEED	178.0000	6.3571	2.0224	4.0899	(28)
TR	2.	SMALL SEED	118.0000	5.9000	1.9167	3.6737	(20)
TR	3	MIXED SEED	178.0000	5.7419	2.3660	5.5978	(31)

TOTAL CASES = 407

FILE SDL2 (CREATION DATE = 12/30/81)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE NOD1 NUMBER OF NODES
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			916.0000	2.2506	0.8281	0.6858	(407)
CUL	0.		211.0000	2.1979	0.8287	0.6867	(96)
TR	1.	LARGE SEED	91.0000	2.3333	0.8983	0.8070	(39)
TR	2.	SMALL SEED	70.0000	2.0588	0.8143	0.6631	(34)
TR	3.	MIXED SEED	50.0000	2.1739	0.7168	0.5138	(23)
CUL	1.	PITIC 62	90.0000	1.7308	0.6893	0.4751	(52)
TR	1.	LARGE SEED	51.0000	1.8214	0.7228	0.5225	(28)
TR	2.	SMALL SEED	23.0000	1.6429	0.7449	0.5549	(14)
TR	3.	MIXED SEED	16.0000	1.6000	0.5164	0.2667	(10)
CUL	2.	GLENLEA	203.0000	2.1596	0.8335	0.6947	(94)
TR	1.	LARGE SEED	67.0000	1.8108	0.9079	0.8243	(37)
TR	2.	SMALL SEED	59.0000	2.1852	0.7357	0.5413	(27)
TR	3.	MIXED SEED	77.0000	2.5667	0.6261	0.3920	(30)
CUL	3.	PARK	210.0000	2.4419	0.7912	0.6260	(86)
TR	1.	LARGE SEED	77.0000	2.7500	0.7515	0.5648	(28)
TR	2.	SMALL SEED	69.0000	2.4643	0.9222	0.8505	(28)
TR	3.	MIXED SEED	64.0000	2.1333	0.5713	0.3264	(30)
CUL	4.	70M009002	202.0000	2.5570	0.7637	0.5833	(79)
TR	1.	LARGE SEED	75.0000	2.6786	0.7724	0.5966	(28)
TR	2.	SMALL SEED	50.0000	2.5000	0.7609	0.5789	(20)
TR	3.	MIXED SEED	77.0000	2.4839	0.7690	0.5914	(31)

TOTAL CASES = 407

FILE SDL2 (CREATION DATE = 12/30/81)

- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - -

CRITERION VARIABLE DW1 DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			545.8599	1.3412	0.5459	0.2980	(407)
CUL	0.		133.3000	1.3885	0.4739	0.2246	(96)
TR	1.	LARGE SEED	55.9500	1.4346	0.3839	0.1474	(39)
TR	2.	SMALL SEED	46.5000	1.3676	0.5154	0.2657	(34)
TR	3.	MIXED SEED	30.8500	1.3413	0.5567	0.3099	(23)
CUL	1.	PITIC 62	75.1700	1.4456	0.5390	0.2905	(52)
TR	1.	LARGE SEED	38.2400	1.3657	0.5833	0.3402	(28)
TR	2.	SMALL SEED	20.4200	1.4586	0.3365	0.1133	(14)
TR	3.	MIXED SEED	16.5100	1.6510	0.6287	0.3953	(10)
CUL	2.	GLENLEA	135.6700	1.4433	0.6330	0.4007	(94)
TR	1.	LARGE SEED	50.5600	1.3665	0.5911	0.3494	(37)
TR	2.	SMALL SEED	38.2200	1.4156	0.8463	0.7197	(27)
TR	3.	MIXED SEED	46.8900	1.5630	0.4279	0.1831	(30)
CUL	3.	PARK	96.1400	1.1179	0.4823	0.2326	(86)
TR	1.	LARGE SEED	30.8200	1.1007	0.5228	0.2734	(28)
TR	2.	SMALL SEED	32.1200	1.1471	0.5261	0.2789	(28)
TR	3.	MIXED SEED	33.2000	1.1067	0.4080	0.1664	(30)
CUL	4.	70M009002	105.5800	1.3365	0.5282	0.2790	(79)
TR	1.	LARGE SEED	42.2500	1.5089	0.5360	0.2873	(28)
TR	2.	SMALL SEED	19.1500	0.9575	0.3585	0.1285	(20)
TR	3.	MIXED SEED	44.1800	1.4252	0.5037	0.2537	(31)

TOTAL CASES = 407

Appendix 15. Descriptive stati[illegible] characters of plants from large, small and mixed si[illegible] seeds, measured at the heading stage, in 1979.

FILE SDL3 (CREATION DATE = 12/30/81)

- - - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - - - -

CRITERION VARIABLE HT1 PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			13481.1000	29.4991	12.6408	159.7905	(457)
CUL	0.		2359.5000	25.6467	9.2767	86.0579	(92)
TR	1.	LARGE SEED	884.5000	24.5694	7.8687	61.9165	(36)
TR	2.	SMALL SEED	800.5000	25.0156	9.2984	86.4594	(32)
TR	3.	MIXED SEED	674.5000	28.1042	11.0029	121.0648	(24)
CUL	1.	PITIC 62	1707.6000	16.1094	3.5036	12.2751	(106)
TR	1.	LARGE SEED	534.5000	16.1970	3.0896	9.5459	(33)
TR	2.	SMALL SEED	509.5000	16.4355	3.9786	15.8290	(31)
TR	3.	MIXED SEED	663.6000	15.8000	3.4956	12.2190	(42)
CUL	2.	GLENLEA	3131.0000	31.0000	5.5937	31.2900	(101)
TR	1.	LARGE SEED	1171.0000	31.6486	2.6401	6.9703	(37)
TR	2.	SMALL SEED	1004.0000	33.4667	5.9494	35.3954	(30)
TR	3.	MIXED SEED	956.0000	28.1176	6.4456	41.5463	(34)
CUL	3.	PARK	4669.0000	47.6429	6.8834	47.3814	(98)
TR	1.	LARGE SEED	1888.5000	49.6974	5.8489	34.2100	(38)
TR	2.	SMALL SEED	1363.5000	45.4500	7.7852	60.6095	(30)
TR	3.	MIXED SEED	1417.0000	47.2333	6.5990	43.5471	(30)
CUL	4.	70M009002	1614.0000	26.9000	6.8345	46.7102	(60)
TR	1.	LARGE SEED	799.5000	30.7500	5.3484	28.6050	(26)
TR	2.	SMALL SEED	314.0000	20.9333	6.0647	36.7810	(15)
TR	3.	MIXED SEED	500.5000	26.3421	5.7760	33.3626	(19)

TOTAL CASES = 457

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FILE SDL3 (CREATION DATE = 12/30/81)

\- - - - - - - - - D E S C R I P T I O N O F S U B P O P U L A T I O N S - - - - - - - - - - - - - -

CRITERION VARIABLE T1 TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE		N
FOR ENTIRE POPULATION			2367.0000	5.1794	2.1002	4.4107	(	457)
CUL	0.		489.0000	5.3152	1.8453	3.4050	(	92)
TR	1.	LARGE SEED	205.0000	5.6944	1.8177	3.3040	(	36)
TR	2.	SMALL SEED	169.0000	5.2813	1.7641	3.1119	(	32)
TR	3.	MIXED SEED	115.0000	4.7917	1.9332	3.7373	(	24)
CUL	1.	PITIC 62	610.0000	5.7547	2.6070	6.7964	(	106)
TR	1.	LARGE SEED	201.0000	6.0909	2.9194	8.5227	(	33)
TR	2.	SMALL SEED	154.0000	4.9677	2.5098	6.2989	(	31)
TR	3.	MIXED SEED	255.0000	6.0714	2.3415	5.4826	(	42)
CUL	2.	GLENLEA	398.0000	3.9406	1.2476	1.5564	(	101)
TR	1.	LARGE SEED	135.0000	3.6486	0.7894	0.6231	(	37)
TR	2.	SMALL SEED	136.0000	4.5333	1.1366	1.2920	(	30)
TR	3.	MIXED SEED	127.0000	3.7353	1.5630	2.4430	(	34)
CUL	3.	PARK	524.0000	5.3469	1.7940	3.2186	(	98)
TR	1.	LARGE SEED	213.0000	5.6053	1.4245	2.0292	(	38)
TR	2.	SMALL SEED	164.0000	5.4667	2.1613	4.6713	(	30)
TR	3.	MIXED SEED	147.0000	4.9000	1.7879	3.1966	(	30)
CUL	4.	70M009002	346.0000	5.7667	2.2727	5.1650	(	60)
TR	1.	LARGE SEED	158.0000	6.0769	2.3482	5.5138	(	26)
TR	2.	SMALL SEED	81.0000	5.4000	2.6673	7.1143	(	15)
TR	3.	MIXED SEED	107.0000	5.6316	1.8622	3.4678	(	19)

TOTAL CASES = 457

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FILE SDL3 (CREATION DATE = 12/30/81)

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CRITERION VARIABLE DW1 DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE		N
FOR ENTIRE POPULATION			1861.8498	4.0741	1.5758	2.4831	(	457)
CUL	0.		370 6800	4.0291	1.5689	2 4616	(	92)
TR	1.	LARGE SEED	152.4700	4.2353	1.5751	2.4808	(	36
TR	2.	SMALL SEED	118 9300	3.7166	1.2028	1 4466	(	32)
TR	3.	MIXED SEED	99.2800	4 1367	1.9493	3.7998	(	24
CUL	1.	PITIC 62	429.9600	4.0562	1 6794	2.8205	(	106
TR	1.	LARGE SEED	137.5900	4.1694	1.6798	2.8216	(	33)
TR	2.	SMALL SEED	125.8500	4.0597	1.7704	3.1343	(	31)
TR	3.	MIXED SEED	166.5200	3.9648	1.6458	2.7086	(	42)
CUL	2.	GLENLEA	407.7400	4.0370	1.4447	2.0871	(	101)
TR	1.	LARGE SEED	142.2700	3.8451	1.0571	1.1175	(	37)
TR	2.	SMALL SEED	142.1300	4.7377	1.5214	2.3148	(	30)
TR	3.	MIXED SEED	123.3400	3.6276	1.5528	2.4111	(	34)
CUL	3.	PARK	393.3400	4.0137	1.4129	1.9963	(	98)
TR	1.	LARGE SEED	170.9700	4.4992	1.3277	1.7627	(	38)
TR	2.	SMALL SEED	111.7000	3.7233	1.4729	2.1695	(	30)
TR	3.	MIXED SEED	110.6700	3.6890	1.3242	1.7536	(	30)
CUL	4.	70M009002	260.1300	4.3355	1.8640	3.4744	(	60)
TR	1.	LARGE SEED	131.0300	5.0396	1 8594	3.4573	(	26)
TR	2.	SMALL SEED	53.8400	3.5893	1.8567	3.4475	(	15)
TR	3.	MIXED SEED	75.2600	3.9611	1.6053	2.5771	(	19)

TOTAL CASES = 457

Appendix 16. Descriptive statistics of characters of plants from large, small and mixed size seeds, measured at maturity, in 1979.

FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

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CRITERION VARIABLE T1 TILLERS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			2210 0000	4 9775	2.0882	4.3607	(444)
CUL	1	PITIC 62	757.0000	5 4460	2.0857	4 3503	(139)
TR	1	SMALL SEED	271 0000	6 1591	2.0903	4 3695	(44)
TR	2	LARGE SEED	236 0000	5 4884	2.4041	5 7796	(43)
TR	3	MIXED SEED	250.0000	4 8077	1 5723	2.4721	(52)
CUL	2	GLENLEA	405 0000	3 7850	1.4144	2 0005	(107)
TR	1.	SMALL SEED	126.0000	3 7059	1.4041	1.9715	(34)
TR	2	LARGE SEED	154.0000	3 8500	1.4597	2 1308	(40)
TR	3	MIXED SEED	125 0000	3 7879	1.4088	1.9848	(33)
CUL	3	PARK	650 0000	5 5556	2.1312	4 5421	(117)
TR	1	SMALL SEED	269 0000	5.8478	2.3567	5 5541	(46)
TR	2.	LARGE SEED	135 0000	5 0000	1.7541	3.0769	(27)
TR	3.	MIXED SEED	246 0000	5 5909	2.0722	4.2939	(44)
CUL	4	70M009002	398.0000	4.9136	2.1517	4 6299	(81)
TR	1	SMALL SEED	129 0000	5 1600	2.1541	4 6400	(25)
TR	2.	LARGE SEED	79 0000	4.3889	1.7197	2 9575	(18)
TR	3	MIXED SEED	190 0000	5 0000	2.3365	5 4595	(38)

TOTAL CASES = 444

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE H1 HEADS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			1984.0000	4.4786	1.8826	3.5442	(443)
CUL	1.	PITIC 62	724.0000	5.2086	2.1382	4.5721	(139)
TR	1.	SMALL SEED	257.0000	5.8409	2.0109	4.0439	(44)
TR	2.	LARGE SEED	230.0000	5.3488	2.6266	6.8992	(43)
TR	3.	MIXED SEED	237.0000	4.5577	1.5770	2.4868	(52)
CUL	2.	GLENLEA	385.0000	3.5981	1.3308	1.7709	(107)
TR	1.	SMALL SEED	118.0000	3.4706	1.3081	1.7112	(34)
TR	2.	LARGE SEED	150.0000	3.7500	1.3540	1.8333	(40)
TR	3.	MIXED SEED	117.0000	3.5455	1.3484	1.8182	(33)
CUL	3.	PARK	541.0000	4.6239	1.7554	3.0815	(117)
TR	1.	SMALL SEED	228.0000	4.9565	2.0865	4.3536	(46)
TR	2.	LARGE SEED	115.0000	4.2593	1.8312	3.3533	(27)
TR	3.	MIXED SEED	198.0000	4.5000	1.2295	1.5116	(44)
CUL	4.	70M009002	334.0000	4.1750	1.6822	2.8297	(80)
TR	1.	SMALL SEED	106.0000	4.2400	1.6653	2.7733	(25)
TR	2.	LARGE SEED	71.0000	3.9444	1.3048	1.7026	(18)
TR	3.	MIXED SEED	157.0000	4.2432	1.8768	3.5225	(37)

TOTAL CASES = 444
MISSING CASES = 1 OR 0.2 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE WT1 DRY WEIGHT PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			7557.7986	17.0991	7.8141	61.0609	(442)
CUL	1	PITIC 62	2900.8994	20.8698	8.9294	79 7335	(139)
TR	1.	SMALL SEED	1039.1998	23.6182	7.8390	61.4494	(44)
TR	2	LARGE SEED	870.3998	20.2419	9.6985	94.0615	(43)
TR	3.	MIXED SEED	991.2998	19.0635	8.7350	76.3008	(52)
CUL	2.	GLENLEA	1891 1996	17 6748	6.9142	47.8060	(107)
TR	1.	SMALL SEED	574.8999	16 9088	6.5454	42 8420	(34)
TR	2.	LARGE SEED	738.2998	18.4575	7.3926	54.6512	(40)
TR	3	MIXED SEED	577.9999	17.5151	6.7938	46.1550	(33)
CUL	3	PARK	1552.4998	13.5000	5.4544	29.7502	(115)
TR	1.	SMALL SEED	620.6999	13.4935	6.4690	41.8486	(46)
TR	2.	LARGE SEED	327.1000	13.0840	5.3005	28.0955	(25)
TR	3	MIXED SEED	604.6999	13.7432	4.3858	19.2351	(44)
CUL	4.	70M009002	1213.1998	14.9778	6.7080	44.9967	(81)
TR	1.	SMALL SEED	364.8000	14.5920	5.5522	30.8266	(25)
TR	2.	LARGE SEED	252.0000	14.0000	4.4623	19.9117	(18)
TR	3	MIXED SEED	596.3999	15.6947	8 1886	67 0524	(38)

TOTAL CASES = 444
MISSING CASES = 2 OR 0.5 PCT

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

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CRITERION VARIABLE Y1 SEED YIELD PER PLANT G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3317.9398	7.5067	3.5062	12.2933	(442)
CUL	1.	PITIC 62	1304.3999	9.3842	3.7672	14.1920	(139)
TR	1.	SMALL SEED	469.3500	10.6670	3.4031	11.5808	(44)
TR	2.	LARGE SEED	399.7500	9.2965	4.4562	19.8579	(43)
TR	3.	MIXED SEED	435.3000	8.3712	3.1323	9.8115	(52)
CUL	2.	GLENLEA	828.4499	7.7425	3.1332	9.8171	(107)
TR	1.	SMALL SEED	253.8500	7.4662	3.0079	9.0474	(34)
TR	2.	LARGE SEED	322.6900	8.0672	3.3804	11.4270	(40)
TR	3.	MIXED SEED	251.9100	7.6336	3.0062	9.0371	(33)
CUL	3.	PARK	638.6600	5.4586	2.3673	5.6042	(117)
TR	1.	SMALL SEED	251.7700	5.4733	2.7728	7.6883	(46)
TR	2.	LARGE SEED	138.4200	5.1267	2.4042	5.7800	(27)
TR	3.	MIXED SEED	248.4700	5.6470	1.8633	3.4718	(44)
CUL	4.	70M009002	546.4300	6.9168	3.1174	9.7180	(79)
TR	1.	SMALL SEED	163.3300	6.5332	2.5457	6.4808	(25)
TR	2.	LARGE SEED	114.4800	6.3600	1.9528	3.8135	(18)
TR	3.	MIXED SEED	268.6200	7.4617	3.8459	14.7911	(36)

TOTAL CASES = 444
MISSING CASES = 2 OR 0.5 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

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CRITERION VARIABLE F1 HEIGHT OF THE FLAG LEAF BLADE CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			27735.0000	62.4662	10.2334	104.7235	(444)
CUL	1.	PITIC 62	8794.0000	63.2662	7 7577	60.1823	(139)
TR	1.	SMALL SEED	2822.0000	64.1364	8.5197	72.5856	(44)
TR	2.	LARGE SEED	2627.0000	61.0930	8.5741	73 5150	(43)
TR	3.	MIXED SEED	3345.0000	64.3269	5 9433	35 3224	(52)
CUL	2.	GLENLEA	7916.0000	73.9813	6.8391	46.7732	(107)
TR	1.	SMALL SEED	2501.0000	73.5588	5.1475	26.4964	(34)
TR	2.	LARGE SEED	3020.0000	75.5000	7.4627	55.6923	(40)
TR	3.	MIXED SEED	2395.0000	72.5758	7.3910	54.6269	(33)
CUL	3.	PARK	6832.0000	58.3932	6.6488	44.2062	(117)
TR	1.	SMALL SEED	2719.0000	59.1087	6 6105	43.6990	(46)
TR	2.	LARGE SEED	1556.0000	57.6296	6.7148	45.0883	(27)
TR	3.	MIXED SEED	2557.0000	58.1136	6.7280	45.2659	(44)
CUL	4.	70M009002	4193.0000	51.7654	5.5997	31 3568	(81)
TR	1.	SMALL SEED	1273.0000	50.9200	4.5636	20.8267	(25)
TR	2.	LARGE SEED	902.0000	50.1111	4.7389	22.4575	(18)
TR	3.	MIXED SEED	2018.0000	53.1053	6.3492	40.3129	(38)

TOTAL CASES = 444

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE									
P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
P609	P610	P611	P612	P613	P615				

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE HT1 PLANT HEIGHT CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			43286.0000	97.4910	12.7777	163.2708	(444)
CUL	1.	PITIC 62	13093.0000	94.1942	7.9526	63.2446	(139)
TR	1.	SMALL SEED	4157.0000	94.4773	8.6736	75.2320	(44)
TR	2.	LARGE SEED	3975.0000	92.4419	8.6059	74.0620	(43)
TR	3.	MIXED SEED	4961.0000	95.4038	6.5237	42.5592	(52)
CUL	2.	GLENLEA	11966.0000	111.8318	8.7561	76.6695	(107)
TR	1.	SMALL SEED	3806.0000	111.9412	5.6619	32.0570	(34)
TR	2.	LARGE SEED	4504.0000	112.6000	11.1328	123.9385	(40)
TR	3.	MIXED SEED	3656.0000	110.7879	8.2453	67.9848	(33)
CUL	3.	PARK	11680.0000	99.8291	7.1091	50.5395	(117)
TR	1.	SMALL SEED	4576.0000	99.4783	7.1701	51.4106	(46)
TR	2.	LARGE SEED	2702.0000	100.0741	7.1572	51.2251	(27)
TR	3.	MIXED SEED	4402.0000	100.0455	7.1657	51.3467	(44)
CUL	4.	70M009002	6547.0000	80.8272	6.0864	37.0448	(81)
TR	1.	SMALL SEED	2008.0000	80.3200	4.6968	22.0600	(25)
TR	2.	LARGE SEED	1416.0000	78.6667	4.4853	20.1176	(18)
TR	3.	MIXED SEED	3123.0000	82.1842	7.2255	52.2084	(38)

TOTAL CASES = 444

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE									
P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
P609	P610	P611	P612	P613	P615				

D E S C R I P T I O N O F S U B P O P U L A T I O N S

CRITERION VARIABLE SP1 SPIKELETS PER HEAD
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			3767.0000	8.4842	1.3728	1.8846	(444)
CUL	1.	PITIC 62	1207.0000	8.6835	1.2742	1.6237	(139)
TR	1.	SMALL SEED	382.0000	8.6818	0.9590	0.9197	(44)
TR	2.	LARGE SEED	365.0000	8.4884	1.5019	2.2558	(43)
TR	3.	MIXED SEED	460.0000	8.8462	1.3044	1.7014	(52)
CUL	2.	GLENLEA	920.0000	8.5981	1.4528	2.1106	(107)
TR	1.	SMALL SEED	297.0000	8.7353	1.6201	2.6248	(34)
TR	2.	LARGE SEED	346.0000	8.6500	1.1447	1.3103	(40)
TR	3.	MIXED SEED	277.0000	8.3939	1.6190	2.6212	(33)
CUL	3.	PARK	942.0000	8.0513	1.4072	1.9801	(117)
TR	1.	SMALL SEED	363.0000	7.8913	1.4020	1.9657	(46)
TR	2.	LARGE SEED	218.0000	8.0741	1.8171	3.3020	(27)
TR	3.	MIXED SEED	361.0000	8.2045	1.1119	1.2363	(44)
CUL	4.	70M009002	698.0000	8.6173	1.2606	1.5892	(81)
TR	1.	SMALL SEED	211.0000	8.4400	1.5297	2.3400	(25)
TR	2.	LARGE SEED	161.0000	8.9444	1.2113	1.4673	(18)
TR	3.	MIXED SEED	326.0000	8.5789	1.0813	1.1693	(38)

TOTAL CASES = 444

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
P609	P610	P611	P612	P613	P615				

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CRITERION VARIABLE HL1 HEADLENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			5138.0000	11.5721	2.6173	6.8503	(444)
CUL	1.	PITIC 62	1947.0000	14.0072	2.0126	4.0507	(139)
TR	1.	SMALL SEED	610.0000	13.8636	1.9952	3.9810	(44)
TR	2.	LARGE SEED	605.0000	14.0698	2.1646	4.6855	(43)
TR	3.	MIXED SEED	732.0000	14.0769	1.9286	3.7195	(52)
CUL	2.	GLENLEA	1275.0000	11.9159	2.3915	5.7193	(107)
TR	1.	SMALL SEED	423.0000	12.4412	2.6537	7.0419	(34)
TR	2.	LARGE SEED	475.0000	11.8750	2.2210	4.9327	(40)
TR	3.	MIXED SEED	377.0000	11.4242	2.2643	5.1269	(33)
CUL	3.	PARK	1108.0000	9.4701	1.2565	1.5788	(117)
TR	1.	SMALL SEED	419.0000	9.1087	1.1968	1.4324	(46)
TR	2.	LARGE SEED	264.0000	9.7778	1.2506	1.5641	(27)
TR	3.	MIXED SEED	425.0000	9.6591	1.2565	1.5788	(44)
CUL	4.	70M009002	808.0000	9.9753	1.2547	1.5744	(81)
TR	1.	SMALL SEED	243.0000	9.7200	1.5144	2.2933	(25)
TR	2.	LARGE SEED	179.0000	9.9444	1.0556	1.1144	(18)
TR	3.	MIXED SEED	386.0000	10.1579	1.1514	1.3257	(38)

TOTAL CASES = 444

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
P609	P610	P611	P612	P613	P615				

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CRITERION VARIABLE K1 NUMBER OF KERNELS PER PLANT
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			80060.0000	181.5420	87.0410	7576.1397	(441)
CUL	1.	PITIC 62	32885.0000	236.5827	101.1156	10224.3609	(139)
TR	1.	SMALL SEED	12100.0000	275.0000	94.9886	9022.8372	(44)
TR	2.	LARGE SEED	10098.0000	234.8372	114.4384	13096.1395	(43)
TR	3.	MIXED SEED	10687.0000	205.5192	83.7474	7013.6271	(52)
CUL	2.	GLENLEA	16012.0000	151.0566	60.3109	3637.4063	(106)
TR	1.	SMALL SEED	4978.0000	146.4118	58.5720	3430.6738	(34)
TR	2.	LARGE SEED	6270.0000	156.7500	65.1833	4248.8590	(40)
TR	3.	MIXED SEED	4764.0000	148.8750	57.0307	3252.5000	(32)
CUL	3.	PARK	17672.0000	151.0427	63.0504	3975.3516	(117)
TR	1.	SMALL SEED	7083.0000	153.9783	75.4570	5693 7551	(46)
TR	2.	LARGE SEED	3815.0000	141.2963	64.9075	4212.9858	(27)
TR	3.	MIXED SEED	6774.0000	153.9545	46.2677	2140.6956	(44)
CUL	4.	70M009002	13491.0000	170.7722	75.2657	5664.9218	(79)
TR	1.	SMALL SEED	4092.0000	163.6800	71.8527	5162.8100	(25)
TR	2.	LARGE SEED	2817.0000	156.5000	49.5548	2455.6765	(18)
TR	3.	MIXED SEED	6582.0000	182.8333	87.1860	7601.4000	(36)

TOTAL CASES = 444
MISSING CASES = 3 OR 0.7 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P408 P409 P410 P411 P412
P414 P415 P501 P502 P503 P504 P506 P507 P508 P510
P511 P512 P514 P515 P601 P603 P604 P605 P607 P608
P609 P610 P611 P612 P613 P615

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CRITERION VARIABLE KWT1 WEIGHT PER 1000 KERNELS G
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			18048.8261	41.7797	6.4682	41.8376	(432)
CUL	1.	PITIC 62	5454.4259	40.1061	3.2004	10.2427	(136)
TR	1.	SMALL SEED	1728.5060	39.2842	3.8546	14.8581	(44)
TR	2.	LARGE SEED	1626.9052	39.6806	2.7071	7.3285	(41)
TR	3.	MIXED SEED	2099.0147	41.1572	2.6730	7.1448	(51)
CUL	2.	GLENLEA	5287.0878	51.3309	3.3685	11.3470	(103)
TR	1.	SMALL SEED	1682.8573	50.9957	3.7968	14.4157	(33)
TR	2.	LARGE SEED	2019.1376	51.7728	2.6568	7.0586	(39)
TR	3.	MIXED SEED	1585.0929	51.1320	3.7207	13.8440	(31)
CUL	3.	PARK	4131.8779	35.9294	2.7837	7.7490	(115)
TR	1.	SMALL SEED	1622.3680	35.2689	2.9099	8.4675	(46)
TR	2.	LARGE SEED	936.7077	36.0272	2.1197	4.4933	(26)
TR	3.	MIXED SEED	1572.8022	36.5768	2.8936	8.3732	(43)
CUL	4.	70M009002	3175.4345	40.7107	3.2354	10.4681	(78)
TR	1.	SMALL SEED	1016.9245	40.6770	3.1805	10.1154	(25)
TR	2.	LARGE SEED	736.0590	40.8922	3.3345	11.1187	(18)
TR	3.	MIXED SEED	1422.4510	40.6415	3.3143	10.9844	(35)

TOTAL CASES = 444
MISSING CASES = 12 OR 2.7 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)
SUBFILE P401 P402 P403 P404 P405 P408 P409 P410 P411 P412
P414 P415 P501 P502 P503 P504 P506 P507 P508 P510
P511 P512 P514 P515 P601 P603 P604 P605 P607 P608
P609 P610 P611 P612 P613 P615

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CRITERION VARIABLE HI1 HARVEST INDEX
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			187.8161	0 4358	0.0538	0.0029	(431)
CUL	1.	PITIC 62	61.2429	0.4503	0.0522	0.0027	(136)
TR	1.	SMALL SEED	19.9006	0 4523	0.0269	0.0007	(44)
TR	2.	LARGE SEED	18.4417	0 4498	0.0781	0.0061	(41)
TR	3.	MIXED SEED	22 9005	0 4490	0.0430	0.0018	(51)
CUL	2.	GLENLEA	45.4604	0.4371	0.0386	0.0015	(104)
TR	1.	SMALL SEED	14.5414	0.4406	0.0520	0 0027	(33)
TR	2.	LARGE SEED	16.9266	0.4340	0.0234	0.0005	(39)
TR	3.	MIXED SEED	13.9924	0.4373	0.0382	0.0015	(32)
CUL	3.	PARK	45.2338	0.4003	0.0513	0.0026	(113)
TR	1.	SMALL SEED	18.5117	0.4024	0.0509	0.0026	(46)
TR	2.	LARGE SEED	9.0780	0.3782	0.0707	0.0050	(24)
TR	3.	MIXED SEED	17.6441	0.4103	0.0336	0.0011	(43)
CUL	4.	70M009002	35.8790	0.4600	0.0524	0.0027	(78)
TR	1.	SMALL SEED	11.2296	0.4492	0.0386	0.0015	(25)
TR	2.	LARGE SEED	8.2453	0.4581	0.0366	0.0013	(18)
TR	3.	MIXED SEED	16.4041	0.4687	0.0658	0.0043	(35)

TOTAL CASES = 444
MISSING CASES = 13 OR 2.9 PCT

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE KH1 NUMBER OF KERNELS PER HEAD
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			17354.5552	40.2658	9.0975	82.7648	(431)
CUL	1.	PITIC 62	6214.6801	45.6952	8.6346	74.5567	(136)
TR	1.	SMALL SEED	2090.5913	47.5134	6.4038	41.0085	(44)
TR	2.	LARGE SEED	1795.3556	43.7892	10.5603	111.5206	(41)
TR	3.	MIXED SEED	2328.7332	45.6614	8.4220	70.9298	(51)
CUL	2.	GLENLEA	4288.7076	41.6379	7.1147	50.6194	(103)
TR	1.	SMALL SEED	1397.9666	42.3626	7.9809	63.6940	(33)
TR	2.	LARGE SEED	1608.0388	41.2318	6.5996	43.5547	(39)
TR	3.	MIXED SEED	1282.7023	41.3775	6.9379	48.1343	(31)
CUL	3.	PARK	3782.0531	32.8874	6.7059	44.9690	(115)
TR	1.	SMALL SEED	1424.4959	30.9673	6.6158	43.7683	(46)
TR	2.	LARGE SEED	878.8301	33.8012	8.4828	71.9577	(26)
TR	3.	MIXED SEED	1478.7272	34.3890	5.0467	25.4689	(43)
CUL	4.	70M009002	3069.1144	39.8586	7.9109	62.5819	(77)
TR	1.	SMALL SEED	961.6916	38.4677	7.8108	61.0091	(25)
TR	2.	LARGE SEED	727.4308	40.4128	8.3496	69.7164	(18)
TR	3.	MIXED SEED	1379.9919	40.5880	7.8525	61.6619	(34)

TOTAL CASES = 444
MISSING CASES = 13 OR 2.9 PCT.

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FILE SDL4 (CREATION DATE = 12/30/81)

SUBFILE	P401	P402	P403	P404	P405	P408	P409	P410	P411	P412
	P414	P415	P501	P502	P503	P504	P506	P507	P508	P510
	P511	P512	P514	P515	P601	P603	P604	P605	P607	P608
	P609	P610	P611	P612	P613	P615				

DESCRIPTION OF SUBPOPULATIONS

CRITERION VARIABLE EL1 EXTRUSION LENGTH CM
BROKEN DOWN BY CUL CULTIVAR
BY TR TREATMENT

VARIABLE	CODE	VALUE LABEL	SUM	MEAN	STD DEV	VARIANCE	N
FOR ENTIRE POPULATION			10413.0000	23.4527	7.3285	53.7066	(444)
CUL	1.	PITIC 62	2352.0000	16.9209	4.4544	19.8415	(139)
TR	1.	SMALL SEED	725.0000	16.4773	6.2226	38 7204	(44)
TR	2.	LARGE SEED	743.0000	17.2791	3.9661	15 7298	(43)
TR	3.	MIXED SEED	884.0000	17.0000	2.7935	7.8039	(52)
CUL	2.	GLENLEA	2775.0000	25.9346	4.5831	21.0051	(107)
TR	1.	SMALL SEED	882.0000	25.9412	4.2990	18.4813	(34)
TR	2.	LARGE SEED	1009.0000	25.2250	4.9948	24.9481	(40)
TR	3.	MIXED SEED	884.0000	26.7879	4.3284	18.7348	(33)
CUL	3.	PARK	3740.0000	31.9658	3.3808	11.4299	(117)
TR	1.	SMALL SEED	1438.0000	31.2609	3.2279	10.4193	(46)
TR	2.	LARGE SEED	882.0000	32.6667	4.2607	18.1538	(27)
TR	3.	MIXED SEED	1420.0000	32.2727	2.8314	8.0169	(44)
CUL	4.	70M009002	1546.0000	19.0864	3.3324	11.1049	(81)
TR	1.	SMALL SEED	492.0000	19.6800	2.5285	6.3933	(25)
TR	2.	LARGE SEED	335.0000	18.6111	3.5170	12 3693	(18)
TR	3.	MIXED SEED	719.0000	18.9211	3.7154	13.8044	(38)

TOTAL CASES = 444

Appendix 17. Distribution parameters of characters of single plants, measured at different stages of growth, derived from large seeds, small seeds and alternated large and small seeds.

All plants were grown in three row plots in 1979. Plants with missing neighbours are excluded.

Character	Skewness[1,2]			Kurtosis[2]		
	Large seed	Small seed	Mixed seed	Large seed	Small seed	Mixed seed
3-5 Leaf Stage:						
Ht_1	-0.78*	-0.85*	-0.38	1.59*	0.92	0.85
L	-0.80*	-0.34	-0.59	2.60**	1.62*	2.18**
T	-0.59	0.03	-0.59	0.91	-0.01	0.81
Wt	0.29	0.07	0.06	1.24	0.39	0.53
Jointing Stage:						
Ht_2	0.11	0.45	0.12	1.04	-0.21	-0.35
N	-0.00	-0.19	-0.21	0.98	0.58	-0.61
T	0.07	-0.44	-0.10	0.36	0.31	0.02
Wt	0.42	0.18	0.30	1.42*	-0.29	0.08
Heading Stage:						
Ht_3	-0.23	-0.39	-0.39	1.01	1.29	1.19
T	-0.57	-0.54	-0.10	0.55	0.32	-0.03
Wt	0.19	0.22	0.15	0.05	-0.59	0.55
Maturity:						
Ht_3	-0.37	-1.22**	-0.49	0.76	2.45**	0.53
T	0.60	0.14	0.39	0.75	0.61	-0.10
Wt	0.33	0.01	0.41	1.02	0.85	0.38
H	0.27	0.18	0.34	0.57	0.64	0.24
FL	0.13	-0.47	-0.12	1.31	0.49	0.24
ExL	0.16	-0.27	-0.06	0.39	3.06**	0.36
HL	0.06	-1.06*	-0.59	1.31	2.91**	0.94
Sp/H	-0.56	-0.59	-0.50	0.85	0.64	0.10
Y/P	0.34	-0.09	0.35	1.15	0.77	0.31
K/P	0.41	-0.06	0.35	1.58*	0.78	0.22
HI	-0.80*	-1.28**	-0.15	1.95**	2.23**	2.38**
Kwt	-0.50	-0.14	-0.51	0.57*	-0.25	0.92
K/H	-0.33	-0.75*	-0.23	1.84**	0.76	1.03

1. Values of skewness and kurtosis are averages of the values of three replicates and four genotypes.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$.

Appendix 18a. Plot yield and Specific Mixture Efficiency[1] of mixtures grown in 1977.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1345	138	1.05	0.10
Glenlea	1249	154		
Glenlea + Park	1278	64	1.10	0.09
Glenlea + Neepawa	1361	179	1.12	0.06
Glenlea + 70M110001	1277	80	0.98	0.05
Glenlea + 70M009002	1346	27	0.98	0.07
Glenlea + Norquay	1352	150	1.02	0.16
Glenlea + NB 701	1353	110	1.09	0.05
Park	1096	105		
Park + Neepawa	1227	130	1.08	0.06
Park + 70M110001	1275	97	1.05	0.16
Park + 70M009002	1401	56	1.07	0.01
Park + Norquay	1364	8	1.04	0.03
Park + NB 701	1347	145	1.16	0.13
Neepawa	1170	86		
Neepawa + 70M110001	1302	153	1.03	0.14
Neepawa + 70M009002	1344	65	1.00	0.01
Neepawa + Norquay	1239	103	0.96	0.04
Neepawa + NB 701	1302	126	1.08	0.03
70M110001	1358	253		
70M110001 + 70M009002	1498	123	1.05	0.06
70M110001 + Norquay	1482	92	1.07	0.03
70M110001 + NB 701	1303	70	1.03	0.19
70M009002	1514	64		
70M009002 + Norquay	1451	114	0.99	0.06
70M009002 + NB 701	1508	88	1.10	0.05
Norquay	1418	108		
Norquay + NB 701	1421	36	1.07	0.07
NB 701	1240	203		

1. See Section 8.2.

Appendix 18b. Plot yield and Specific Mixture Efficiency of mixtures grown in 1978.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1012	138	1.02	0.07
Pitic 62	966	251		
Pitic 62 + Glenlea	1111	116	1.11	0.07
Pitic 62 + Park	1014	47	1.08	0.11
Pitic 62 + Neepawa	1112	61	1.08	0.13
Pitic 62 + 70M110001	1105	92	1.09	0.08
Pitic 62 + 70M009002	1006	47	1.11	0.05
Pitic 62 + Norquay	912	79	0.92	0.13
Pitic 62 + NB 701	993	229	1.04	0.03
Glenlea	1043	138		
Glenlea + Park	1085	62	1.10	0.09
Glenlea + Neepawa	1087	115	1.02	0.20
Glenlea + 70M110001	1197	27	1.13	0.02
Glenlea + 70M009002	1067	48	1.13	0.10
Glenlea + Norquay	1063	57	1.02	0.02
Glenlea + NB 701	912	160	0.92	0.10
Park	933	57		
Park + Neepawa	1023	77	1.00	0.06
Park + 70M110001	911	40	0.91	0.00
Park + 70M009002	815	84	0.91	0.09
Park + Norquay	992	118	1.00	0.07
Park + NB 701	880	186	0.93	0.10
Neepawa	1112	92		
Neepawa + 70M110001	1007	125	0.92	0.10
Neepawa + 70M009002	1000	92	1.02	0.13
Neepawa + Norquay	1141	103	1.06	0.12
Neepawa + NB 701	1127	105	1.10	0.11
70M110001	1078	113		
70M110001 + 70M009002	873	124	0.92	0.11
70M110001 + Norquay	1054	66	0.99	0.04
70M110001 + NB 701	1050	168	1.03	0.08
70M009002	859	159		
70M009002 + Norquay	873	2	0.92	0.05
70M009002 + NB 701	894	175	0.99	0.16
Norquay	104[illegible]	38		
Norquay + NB 701	110[illegible]	31	1.12	0.08
NB 701	9[illegible]	179		

Appendix 18c. Plot yield and Specific Mixture Efficiency of mixtures grown in 1979.

Mixture	Plot yield (g)		Specific Mixture Efficiency	
	Mean	Std. Dev.	Mean	Std. Dev.
For Entire Population	1248	140	1.03	
Pitic 62	1342	80		
Pitic 62 + Glenlea	1436	36	1.09	0.10
Pitic 62 + Park	1313	11	1.11	0.06
Pitic 62 + Neepawa	1339	59	1.10	0.05
Pitic 62 + 70M110001	1379	29	1.05	0.09
Pitic 62 + 70M009002	1511	80	1.14	0.02
Pitic 62 + Norquay	1437	99	1.19	0.13
Pitic 62 + NB 701	1401	123	1.05	0.12
Glenlea	1312	166		
Glenlea + Park	1238	99	1.06	0.03
Glenlea + Neepawa	1199	75	1.00	0.13
Glenlea + 70M110001	1175	81	0.91	0.11
Glenlea + 70M009002	1313	112	1.01	0.14
Glenlea + Norquay	1271	90	1.08	0.20
Glenlea + NB 701	1272	63	0.97	0.08
Park	1033	104		
Park + Neepawa	1002	38	0.94	0.04
Park + 70M110001	1153	34	1.00	0.04
Park + 70M009002	1212	40	1.04	0.01
Park + Norquay	1082	73	1.02	0.03
Park + NB 701	1324	134	1.12	0.08
Neepawa	1102	125		
Neepawa + 70M110001	1122	44	0.94	0.05
Neepawa + 70M009002	1178	36	0.98	0.04
Neepawa + Norquay	1067	58	0.98	0.08
Neepawa + NB 701	1181	30	0.97	0.02
70M110001	1290	130		
70M110001 + 70M009002	1285	67	1.00	0.08
70M110001 + Norquay	1141	22	0.96	0.07
70M110001 + NB 701	1175	167	0.90	0.14
70M009002	1299	43		
70M009002 + Norquay	1301	62	1.10	0.09
70M009002 + NB 701	1307	45	1.00	0.02
Norquay	1082	12[illegible]		
Norquay + NB 701	1226		1.01	0.07
NB 701	1327			

Appendix 19. Performance of mixtures in each of the three years, containing specific genotypes, as expressed by the Array mean yield (Array $\overline{Y}$), the Average Mixture Efficiency (AME)[1,2], and the General Combining Ability (GCA)[2].

Year	Genotype	Array $\overline{Y}$	Std. Dev.	AME	GCA
1977	Pitic 62	--	--	--	--
	Glenlea	1317	118	1.04**	-28.0
	Park	1280	134	1.07**	-71.8*
	Neepawa	1278	134	1.04**	-69.4*
	70M110001	1357	152	1.02*	17.3
	70M009002	1438	104	1.03*	100.9*
	Norquay	1391	121	1.03*	51.0*
	NB 701	1354	138	1.07**	-0.0
1978	Pitic 62	1028	142	1.05**	7.6
	Glenlea	1071	119	1.05**	54.3
	Park	957	121	0.99	-52.2
	Neepawa	1076	106	1.02*	65.6*
	70M110001	1035	138	1.00	24.5
	70M009002	924	128	1.00	-86.1*
	Norquay	1024	110	1.01	13.0
	NB 701	988	177	1.02*	-26.6
1979	Pitic 62	1395	92	1.09**	129.4*
	Glenlea	1277	116	1.01	32.1
	Park	1170	137	1.04**	-81.8*
	Neepawa	1149	112	0.99	-91.5*
	70M110001	1215	117	0.97**	-19.6
	70M009002	1301	112	1.03**	49.8*
	Norquay	1201	145	1.04**	-51.8*
	NB 701	1277	119	1.00	33.4

1. See Section 8.2.

2. * significant, $\alpha \leq 0.05$; ** significant, $\alpha \leq 0.01$

Appendix 20.

Calculation of the effect of skewness on single plant selection.

Assume a 50:50 mixture of two genotypes G1 and G2. The mean value for a character X of G1 is 0.3589 σ less than the mean of this character for G2. (The value of 0.3589 had to be chosen due to the restricted number of values listed in chi-square tables). Assume further that X has a chi-square distribution with 30 degrees of freedom, and thus a variance of 2x30, a skewness of 0.516, and a kurtosis of 0.400. If the 0.75% of the population having the highest values for X were selected, the selected fractions would consist of 1/3 G1 and 2/3 G2 (Figure 5). The probability of selecting G1 rather than G2 is P(Error)=0.333.

If the character, X, had had a standard normal distribution, it can be found, through trial and error, that:

$P(z>2.29)=0.011$

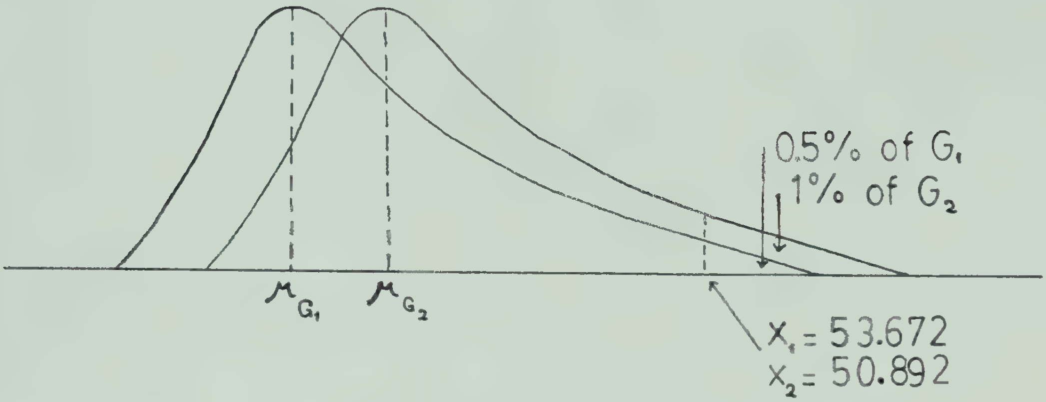
$P(z>2.29+0.3589)=P(z>2.6489)=0.00401$

Total selected fraction=(0.011+0.00401)/2=0.0075

The probability to select G1 rather than G2 is

P(Error)=0.00401/0.01501=0.267.

The probability to select G1 rather than G2 is thus 0.333/0.267=1.25 times larger in the case where the distribution of X is skewed, than in the case where the



d.f. = 30

$\sigma^2 = 2 \times 30 = 60$

Skewness = 0.516

Kurtosis = 0.400

$$\mu_{G_1} - \mu_{G_2} = \frac{53.672 - 50.892}{\sqrt{60}} = 0.3589$$

Fig. 5. Graphic illustration of selection in a 50:50 mixture of two genotypes, G_1 and G_2, for a character x, which has a positively skewed distribution. The selected fraction would, in this case, consist of 1/3 G_1 and 2/3 G_2.

disribution of X is normal.

P(Error) will increase, however when the frequency of G2 in the population decreases.

Assume a mixture of G1 and G2, with means for the character X which are 1.096 σ apart, and in which the frequency of G2 is 1/10 the frequency of G1. The distribution of X is the same as in the previous example. If this time 0.11% of the population is selected, then the probability of selecting G1 rather than G2 is

$$P(\text{Error}) = \frac{10(0.0005)}{0.005 + 10(0.0005)} = \frac{0.005}{0.01} = 0.5$$

If X had had a standard normal distribution, then it can be found, by trial and error, that

$$P(z > 2.41) = 0.008$$

$$P(z > 2.41 + 1.096) = P(z > 3.506) = 0.0002$$

$$P(\text{Error}) = 10(0.0002)/(10 \times 0.0002 + 0.008) = \text{[illegible]}$$

The probability to select G1 is thus 5/2=2.5 times larger in the case where X is skewed than in the case of a normal distribution of X.

On the other hand, if the distribution of X is negatively skewed, and has a curve which is the mirror immage of the curve used in the above examples, the probability to select the superior genotype, G2, is greater than would be the case if X were normally distributed.

For a 50:50 mixture of G1 and G2, with the means 0.151 s apart, it can be calculated, in the same manner as before, that the probability to select G2 is 1.19 times greater than would be the case for a normal distribution, if 0.75 % of the population is selected. If the ratio of G1:G2 is 10:1, and the means are 0.3851 s apart, the probability to select G2 rather than G1 is 1.49 times greater than would be the case if X were normally distributed and 0.11% were selected.